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THE TRANSACTIONS

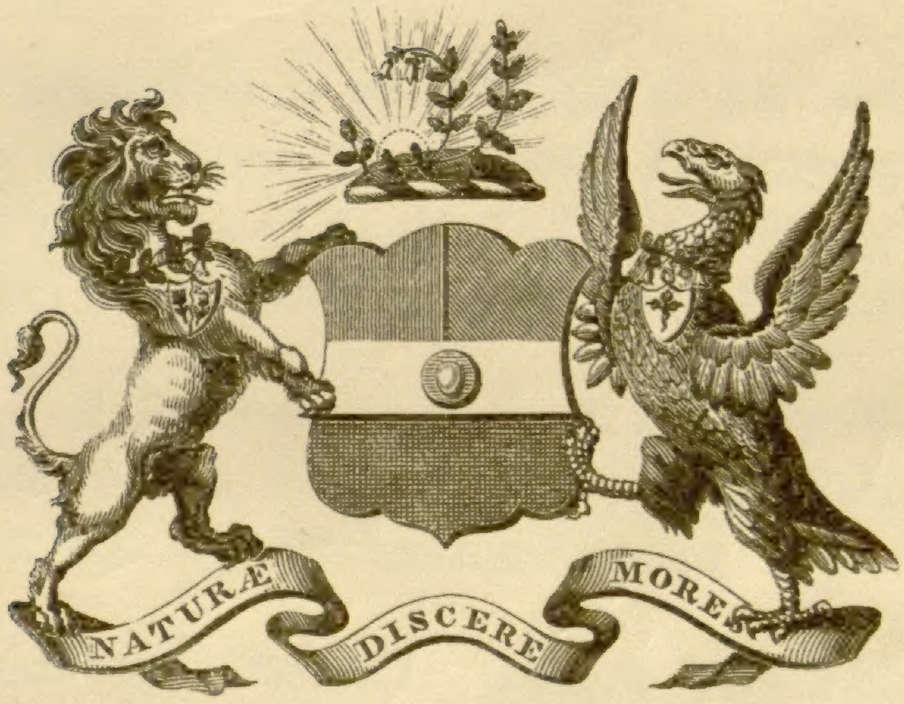
OF

THE LINNEAN SOCIETY

OF

LONDON.

VOLUME XXVI.



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M.DCCC.LXX.

1870

MISSOURI
BOTANICAL
GARDEN.

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(Plates I.–VI.)

Read November 15th, 1866.

My numerous friends in all parts of the world have for so many years intrusted me with their extensive and valuable collections of Grasses, that I have long been extremely anxious to make the knowledge which I have acquired in examining these specimens, which may be counted by tens of thousands, of some use to botanists generally. Up to the present, I fear, all I can say is that, in addition to some short papers published in different 'Transactions,' I have carefully examined all Grasses sent to me, and to the best of my judgment authenticated and named a very large number in the Hookerian Herbarium, the British Museum, the Museum of Trinity College, Dublin, A. Gray's and Bentham's own herbariums, and also some of the Canadian and New York herbariums.

My roving life as a soldier has hitherto, of course, interfered much with any long-continued systematic study, such as would be necessary to complete a monograph of any of the divisions of the Gramineæ sufficiently carefully and fully to be worthy of being offered to botanists generally.

Recently I have had more leisure, and access, through the liberality of my friends, to the best botanical libraries in England. I therefore have now much pleasure in making a beginning, by offering to the Linnean Society a memoir on the Bambusaceæ, a very important division of Gramineæ, although in the number of species it is exceeded by many (indeed nearly all) other divisions. Ruprecht, in 1839, published an excellent memoir on Bambuseæ, in the fifth volume, second series, of the 'Proceedings' of the Imperial Academy of St. Petersburg, which really, as far as the species then known are concerned, is quite exhaustive of the subject. I will not, therefore, attempt to enter into the interesting details of the earlier history of Bamboos, of their general structure, or the writings of Rumph, Rheede, and others of the older botanists on the subject.

Every one who has travelled in the countries where the Bamboos prevail can give instructive accounts of the multitudinous uses to which they are applied. During the last summer very many gardeners, in England even, have been in the habit of using almost daily a Bamboo which is sold abundantly in Covent Garden and elsewhere, for sticks for supporting plants, instead of the old-fashioned green ones. This is, I believe, a species of *Phyllostachys*. Rumph says that the Malays, in his time even, believed that the hollow stem of a Bamboo was the original womb of Man. The seeds and young shoots of Bamboos are eaten by men, the leaves as fodder by horses; and these leaves again, in some countries form the principal portion of the roofs of the houses, and the stuffing of comfortable beds, as the split stems do the mats for the floors in a large number of houses, in Madras especially. Good cordage and paper is made from the fibre, good houses and furniture, and even fishing-contrivances from the stems. A valuable medicine, *Tabasheer*, which, I believe, still bears a high price, is found in the joints of several species, especially, according to Roxburgh, in that of the *Melocanna bambusoides*, the cavity between the joints of which is nearly filled with it. The natives call it *Chuna Lime*. Sir Emerson Tennent, in the first volume of his work on Ceylon, mentions one very curious use to which Bamboos are applied in Malacca. He says, "In the Malayan peninsula the living Bamboo has been converted into an instrument of natural music, by perforating it with holes, through which the wind is permitted to sigh in the most charming manner." . . . "Mr. Logan, in 1847, in approaching the villages of Kandingu, contiguous to the frontier of the European settlement of Malacca, heard sounds, some soft and liquid like the notes of a flute, and others deep and full, like the tones of an organ. On drawing near to a clump of trees, a slender Bamboo, 40 feet in height, was observed; and it was ascertained that the musical tones issued from it, and were caused by the breeze passing through perforations in the stem. The instrument thus formed is called by the natives *Bulu perindu*, or plaintive Bamboo. Those which Mr. Logan saw had a slit in each joint, so that each stem possessed fourteen or twenty notes." I will not, however, enter into further details on this interesting and utilitarian part of the subject, quite agreeing, as I do, with Dr. Hooker, who says, in his 'Himalayan Journals,' that it would take many pages to describe the numerous purposes to which the various species of Bamboo are put. The Chinese, it is said, use the Bamboo for nearly everything they require, even to packing the tea which they send all over the world.

Ruprecht, who had, apparently, free access to the Willdenow Herbarium, the specimens in the British Museum collected in Nepal by Wallich, in 1821, and the Peninsula Bamboos, collected by Wight, describes nine genera and sixty-seven species in all, of which he had seen fifty-five in flower. Of these I have been obliged to reduce about five, thus leaving fifty. In the following pages I have described upwards of 170 species of twenty genera, showing how largely our knowledge of this family has increased in the last twenty-five years. Yet there are many more, doubtless, still to describe, judging from the leaves that I have seen of several species, which I have been unable to make much use of without the flowers.

The difficulty of procuring the flowers of Bamboos is often very great. Roxburgh, an

excellent observer, states that he never more than once saw *Bambusa Balcooa* in flower; and I have only seen four specimens of it in the very large collections I have had access to. Humboldt, referring to this subject, says, "Mons. Mutis herborized for twenty years in the country where *Bambusa Guadua* formed marshy forests, several leagues broad, without being able to procure a flower;" and the flowers of this species, I would observe, are still very rare. Humboldt mentions as an interesting fact, that Bonpland found it *once* in flower. I have seen a few flowering specimens, collected by Mr. Spruce on the Rio Negro, near the Cassiquiare River, the very locality indicated by Humboldt. This rarity of flowering specimens had often induced me to believe that the Bamboos generally, with one notable exception, unlike most Grasses, were extremely limited in their distribution.

However, some of the species which flower annually, as the male Bamboo (*Dendrocalamus strictus*), and can thus be easily collected, are ascertained to be widely distributed: *D. strictus* is found over a large portion of India, North and South, East and West, Burmah, Tenasserim, and Japan.

Some of the *Arundinariæ* also, which die down to the ground every year and, springing up again, flower annually, are often found in Collections. Flowering specimens of the true *Bambusa arundinacea* are also common in herbariums, although the plant takes a long time in coming to the flowering state. It is, however, very widely spread, and always must attract attention when in flower. I may here mention that Dr. Hooker is of opinion that this Bamboo does not flower at any prescribed age, as is commonly supposed, but at any period when full-grown and the circumstances of the season are favourable to its flowering.

This opinion is confirmed by numerous statements from various careful observers, collected together in the 13th and 14th volumes of the Journal of the Agricultural and Horticultural Society of India. The late Sir W. Sleeman stated, as a fact observed by himself, that in 1836 all the large Bamboos in the Deyrah-Dhoon, which had been the principal feature of beauty in the valley for the last twenty-five years, ran to seed and died. Those which had been transplanted during the previous season, and those transplanted twenty years previously, all died together. He also adds that it was generally believed in the valley that a man who had seen two seedings of the Bamboo must be about sixty years old. Dr. Wallich mentions that a celebrated grove of Bamboos, which surrounded the city of Rampore, in Rohilcund, blossomed universally in 1824, and every stem died; and he was informed that the same event had happened forty years previously. Mr. Spilsbury states that all the Bamboos between Jubbulpore and Mundlah seeded in 1839, and died shortly afterwards. Similar facts as to the death of whole forests of Bamboos after flowering are mentioned about the *Melocanna bambusoides* (*Bambusa baccifera*, Roxb.), which flowered generally in Tipperah, Rungpore, Arracan and Chittagong, 1863–66, and died immediately afterwards, causing considerable inconvenience in Tipperah in following years, in consequence of the absence of all Bamboo fitted for building-purposes. In opposition to these statements, Dr. Anderson, the able Superintendant of the Botanical Gardens at Calcutta, states that in 1857 and 1858 many of the Bamboos near Calcutta and on Parasnath flowered and seeded, but in no case that he

was aware of, did a general death of the Bamboo follow. So far as he observed, only the flowering-shoots died; and their place was taken by young shoots springing from the roots; but during the flowering and seeding the foliage almost entirely disappeared. He adds that when the *Bambusa gigantea* at Calcutta, after thirty years, flowered for the first time in 1861, the plants, although weakened, remained alive.

How important an event the general flowering of the Bamboo is, may be learnt from the perusal of the astonishing, but authentic, accounts contained in the Journal above referred to. Amongst these facts it is stated that in 1812, in Orissa, a general flowering of the Bamboo took place, and prevented a famine. The seed gave sustenance to thousands, and very many subsisted entirely on it. Hundreds of people were on the watch day and night to secure the seeds as they fell from the branches. Mr. Shaw Stewart, the Collector, of Canara, on the western coast of India, states that in 1864 there was a general flowering of the Bamboo in the Soopa jungles, and that a very large number of persons, estimated at 50,000, came from the Dharwar and Belgaum districts to collect the seed. Each party remained about ten or fourteen days, taking away enough for their own consumption during the monsoon months, as well as some for sale; and adds that the flowering was "a most providential benefit during the prevalent scarcity." Mr. Gray, writing from Malda in 1866, says, "In the south district, throughout the whole tract of country, the Bamboo has flowered, and the seed has been sold in the bazaar at thirteen seers (twenty-six pounds) for three rupees, rice being ten seers, the ryots having stored enough for their own wants in addition. Hundreds of maunds (the maund being 100 pounds) have been sold in the English bazaar at Malda; and large quantities have been sent to Sultangunge and other places twenty-five to thirty miles distant, showing how enormous the supply must have been." Mr. Gray adds, "The Bamboo harvest has been quite providential, as the ryots were on the point of starving."

I have divided the Bambusaceæ into three divisions:—The first the one generally adopted, namely, *Triglossæ* or *Arundinariæ*, in which all the species have 3 stamens and 3 squamulæ, and the stems are invariably without thorns. In this there are 8 genera:—ARUNDINARIA, containing about 30 species; THAMNOCALAMUS, found only in the Himalayas; PHYLLOSTACHYS, a beautiful genus found in Japan, Amoy, China, and the north of Burmah, with very peculiar foliage, and likely to be popular in cultivation; ARTHROSTYLIDIUM, AULONEMIA, MEROSTACHYS, PLATONIA, and CHUSQUEA,—the latter containing upwards of 30 species, and ascending nearly as high in the Andes as *Arundinaria* does in the Himalayas.

The second division of true Bamboos contains only 5 genera:—NASTUS; BAMBUSA, with 26 species; GUADUA with 10 (this genus is very closely allied to *Bambusa*, and is principally distinguished by its locality, being found only in South America); GIGANTOCHLOA (also very close to *Bambusa*); and OXYTENANTHERA, a genus which I have found it necessary to create, to contain some species distinguished by a very long linear fruit, and very long pointed anthers.

The third division consists of berry-bearing Bamboos, in 8 genera. These are all extremely interesting from their peculiar fruit. The pistil generally appears to be contained in an envelope somewhat analogous to the sac, or utricle, or perigynium,

which contains the seed of *Carex*. In the young state this is so closely attached to the style that it is almost impossible to separate it; in advancing to maturity it increases in various ways. In MELOCANNA *bambusoides* it becomes very fleshy, and the fruit attains the size of a largish pear, whilst the seed remains comparatively small. This is the case, to a less extent, in BEESHA of Rheede, whilst in some of the other genera it forms a very thin covering to the seed, which is often, at maturity, inwardly quite free, and easily detached, as in PSEUDOSTACHYUM, figured at Tab. IV., SCHIZOSTACHYUM *acutiflorum*, and perhaps in other species; for, unfortunately, perfect seeds are very rare. The scutellum is concealed by the envelope referred to above, and is not visible externally, except, perhaps, in some of the species of DENDROCALAMUS; whereas in true Bamboos the seed is very generally like Oats or Wheat, linear or oblong linear, with a distinct furrow down one side, with the scutellum very visible below; and the style articulated at the top of the fruit, and never persistent. In *Schizostachyum acutiflorum* above referred to, a very curious bundle of hairs is to be found at the scutellum; and the pericarp in this instance is quite loose and rugose, and the fruit oblong. I have not seen perfect fruit in any other species of *Schizostachyum*, which I often cannot help thinking is an imperfect state of *Melocanna*, or some allied genus.

The fruit of PSEUDOSTACHYUM is in form exactly like the seed of *Anagallis arvensis*, and the whole plant is very curious in appearance. In BEESHA, TEINOSTACHYUM and CEPHALOSTACHYUM the fruit is long-beaked, and in the two latter genera tapering at the base. BEESHA of Rheede (*Ochlandra* of Thwaites) is distinguished by its numerous stamens, frequently 20 and upwards, dimorphous spiculæ, the fertile one being very frequently sessile near the main axis. One species of this genus is remarkably well figured by Rheede in plate lx. vol. v. of the 'Hortus Malabaricus.' *Teinostachyum* has very long spiculæ, containing several perfect flowers, whereas in *Cephalostachyum* there is only one perfect flower in the spiculæ, a number of which are collected together in dense heads. DINOCHLOA has a very small, rounded, beaked fruit, and has smaller flowers than perhaps any other species of the whole family, but has a large branching panicle. It approaches very closely to some species of *Chusquea*, from which genus it is very easily distinguished at first sight, by having 6 stamens and a trifid style. In the remaining genus, DENDROCALAMUS, perhaps most readily distinguishable from *Bambusa* by its very long, slender style, and the absence of true squamulæ, the fruit is of two forms; and I might probably have been justified in forming some of the species into another genus, but I have been very anxious to avoid the multiplication of genera as far as possible.

In *D. strictus* and its allies the fruit is very smooth, as if polished, on the surface, except at the extreme top, suddenly pointed into a short, sharp, and rather hairy persistent beak. In *D. giganteus* and its allies the beak is very soon caducous; the fruit is hairy at the upper end, and not at all polished, and the scutellum is outwardly visible below on one side.

Having given full descriptions of the genera and species in the following pages, I will not enter into further details here.

I have not, with the exception of *Platonia*, included in Bambusaceæ any genus which

has not the leaves articulated at the base, below the petiole. For this and other reasons I have not included the following genera, which are sometimes placed in Bambusaceæ by authors:—*Pariana*, Aublet; *Orthoclada*, P. de B.; *Uniola*, Linn.; *Diarrhena*, Rafin.; and *Streptogyna*, P. de B. I feel considerable doubts about the latter genus, which has articulated leaves, and several points of structure analogous to Bambusaceæ; but the presence of awns in the paleæ, and the short oblique-pointed callus, induce me to believe, in the absence of perfect fruit, that the plant is most nearly allied to *Arundo*.

In describing the flowers of Bambusaceæ I have made use of the word "palea" in place of flowering glume, as recommended and used by our excellent President, Mr. Bentham; and I have done so with great diffidence, believing, as I do, that the lower palea is in some sense a flowering glume, and in some of the Bamboos especially it is extremely difficult to distinguish between the glume and the lower flowers with only one palea. However, in general, as soon as the flower becomes hermaphrodite the distinction is well marked. In using the word "palea" I have, I confess, paid some attention to expediency, which, I think, ought not altogether to be neglected in works on systematic botany. The word has the advantage of being short, and, whether accepted generally or not, is certainly understood by all botanists; and by its use I have hoped to assist many who are accustomed either to it or to a term of similar purport, as distinguished from "glumes," in the writings of nearly all the principal authors on Gramineæ, as Palisot de Beauvois, Robert Brown, Trinius, Kunth, Nees ab Esenbeck, Steudel, and others. The word "palea" is also, I think, correct, as it originally means chaff, and in many Grasses the chaff is as much composed of the lower palea as of the upper one, to which alone our President confines the term. In some species of *Schizostachyum* there is no upper palea.

I have followed Kunth, Endlicher, and other authors in using the word "squamulæ" for those portions of the flowers of Grasses which may be considered analogous to petals in other plants. These have been called by various botanists "scales," "nectary," "lodiculæ," "parapetala," &c. In Bambusaceæ these are very interesting, and of considerable value in defining species and genera. They are generally present, and in the division *Triglossæ* or *Arundinariæ*, I believe, always so. In *Dendrocalamus*, *Dinochloa*, one species, at least, of *Schizostachyum*, and *Oxytenanthera* they are always absent. In *Beesha* the squamulæ are numerous. In *Pseudostachyum* three squamulæ are sometimes increased to five, and, with the two paleæ, are persistent and spreading, and assume the appearance of a five- to seven-petalled flower; to which deception the fruit, as already mentioned, shaped exactly like the seed-pod of *Anagallis arvensis*, lends its aid. In *Gigantochloa*, a genus in which the stamens are monadelphous, there are occasionally one or two irregularly-shaped scales, which are never nerved, and appear to me to be adventitious, and to owe their origin either to a separation of a portion of the staminal tube or some other unexplained cause. I always find that the first squamula to become deficient is that which is opposite to the upper palea. It is also remarkable that, in most instances where the squamulæ are deficient altogether, the upper palea loses its tendency to be keeled and few-nerved, and becomes rounded on the back and many-nerved. And I would here observe that the flowers of Bamboosæ require very

careful examination, and give much trouble from the time they take to moisten thoroughly. Several spiculæ should be examined, as they often vary much in structure in the same panicle. Sometimes squamulæ will be found in the lower flower, and not in the upper, and sometimes this will be reversed. As a rule, the penultimate hermaphrodite flower is the most perfect, and often, in many-flowered spiculæ, the only one that produces seed. Abnormal flowers are by no means uncommon occurrences; I have sometimes seen two or three pistils instead of one, and very often I find the points of the anthers becoming gradually prolonged into imperfect styles.

The spathes or large sheaths which cover the nodes of the lower portions of all Bamboos, vary much in size and appearance, and will, I think, afford good characters when they are more studied and better known. Dr. Brandis has paid considerable attention to this subject; but these sheaths do not appear, in general, to have attracted the notice of collectors. In the Palm-house at Kew the spathes of *Bambusa vulgaris*, and of *Dendrocalamus giganteus*, are in great perfection, and will show at once how greatly these portions of the plants differ in various species. Another and very curious, almost unique, feature in several species of Bamboo, principally found in Java and the adjoining islands, may be mentioned. I allude to the fibres which hang down from the lower nodes of the older stems. The lowest of these sometimes enter the ground and become rooted, whilst others become two inches and more in circumference, and are frequently converted into spines, bending downwards, which seem well to deserve the name of "horrid." This is stated to occur most conspicuously in *Bambusa maxima*, Poir., the flowers of which, unfortunately, are unknown.

In the description of species I have used the word "rhachilla" to signify the small rhachis or axis of the individual spicula. I will only add that, in every instance where I have had access to a specimen, I have described the species from actual examination by myself; and to all these I have added V. S. When I have not seen a specimen, I have added S. V. (*specimen visum*) by the author from whom I have taken the description.

The geographical distribution of the Bamboo is very interesting. One species only, under the several names of *Bambusa vulgaris*, *B. Thouarsii*, *B. surinamensis*, and *B. Sieberi*, is found in both hemispheres; and I am in considerable doubt as to which it is a native of. I have seen it collected by Wallich in Silhet, by Hooker in Chittagong, but marked by both as cultivated; from Ceylon, apparently wild; from the Mauritius, I think, cultivated; abundantly from the West Indies naturalized; and, cultivated, from several parts of South America. This is the only thoroughly cosmopolitan species, and is to be seen in great perfection near the centre staircase in the Palm-house at Kew. The whole of many of the genera of the subtribe *Triglossæ*, namely *Arthrostylidium*, *Merostachys*, *Aulonemia*, *Platonia*, and *Chusquea*, in all containing nearly 50 species, are confined to the Western hemisphere, some of the *Chusqueæ* attaining an elevation of 10,000 to 12,000 feet above the sea. *Phyllostachys* and *Thamnocalamus* are found only in the East; and the remaining genus *Arundinaria* is found in both hemispheres, some of the species attaining to great elevations in the Himalayan and adjoining mountains. *Arundinaria spathiflora* and *A. racemosa* have been found by Hooker and

Thomson on Singalelah, a mountain on the Islumbo pass, between Eastern Nepal and Sikkim, at an elevation of 11,000 feet. The distribution of many of these *Arundinariæ* seems to be limited more by elevation than by any other cause. At the same time I would observe that at least three or four species appear to be peculiar to Ceylon, one to the Neilgherries, and one or two to Hong Kong. Jameson mentions that *Chusquea aristata*, Munro, makes its first appearance at 13,000 feet elevation on the eastern chain of the Andes, and that at 15,000 feet it completely covers the whole surface, forming what the natives call a "Carizal," impenetrable to man or beast, and continuing upwards to nearly the limits of perpetual snow. It is certainly very curious that a tessellated *Chusquea* should attain this great elevation on the Andes, and a tessellated *Arundinaria* should occur nearly as high in the Himalayas.

The whole of the eight genera of the berry-bearing Bamboos are to be found only in the East, some species of the genera *Cephalostachyum*, *Dendrocalamus*, and *Pseudostachyum* attaining considerable elevations. Of true Bamboos, *Guadua* (if it is a good genus) is confined entirely to America, and the whole of the other species of this division, with the sole exception mentioned above of *Bambusa vulgaris*, are confined to Africa and the East. I have only seen one uncultivated Bamboo from Africa in flower; and that was found in Angola by Dr. Welwitsch, and is most probably the same as *Bambusa abyssinica* of Richard. Ruprecht certainly describes *Bambusa capensis*, and Burchell's herbarium contains one good specimen in flower; but I believe this is a cultivated plant, probably introduced from India, called *Bambusa vulgaris* by Nees, and identical with *Bambusa Balcooa* of Roxburgh. I have also seen some leaves of a species of *Arundinaria* from the Cape, called by Nees *Nastus tessellatus*. Flacourt mentions that a whole province of Madagascar is called Galembulu, from a species of Bamboo called Bulu which is prevalent there; and Ellis also, in his book on Madagascar, says that four very beautiful different kinds of Bamboo contribute much, by the extreme elegance of their growth, to the beauty of the scenery in that island. I have, through the kindness of M. Brongniart, been permitted to examine the Bamboos collected in Madagascar, belonging to the Muséum d'Histoire Naturelle de Paris, containing flowering specimens of three species, which are, strange to say, all berry-bearing Bamboos. One of them is marked "Voulou of the natives," and is probably the same as the Bulu referred to by Flacourt. It is *Beesha? capitata*, Munro, *Nastus capitatus* of Kunth. Another is a new species of *Cephalostachyum*, a genus found in the Eastern Himalaya and Tenasserim. And the third is a slender one which I had previously named *Schizostachyum parvifolium*, from a specimen collected by Gerrard. It is probably the plant described by Ellis as "an elegant slender creeper, with a stem scarcely as thick as a quill, growing 9 to 10 feet long, and hanging in most elegant festoons from tree to tree alongside of the roads." I have seen from the Mauritius *Nastus borbonicus*, which Bory describes as covering a vast extent of country in the higher portions of the island, also *Melocanna bambusoides* and *Bambusa vulgaris*. Numerous species are found in Ceylon and India, and the most gigantic of all in Tenasserim and the islands of the Eastern Archipelago. A specimen of the stem of *Dendrocalamus giganteus* (*Bambusa gigantea*, Wallich), in the British Museum, received from Pulo Geum, measures $25\frac{3}{4}$

inches in circumference. This species has now flowered abundantly in the Calcutta Botanical Gardens, and is thriving extremely well in the Palm-house at Kew. Dr. Brandis, who has collected nineteen species of Bamboo in Burmah, Pegu, and Tenasserim, fourteen of which I have seen specimens of, although only eight were in flower, and therefore capable of identification, states that one species, which I believe to be hitherto undescribed, and have called after the discoverer *Bambusa Brandisi*, attains a stature of 120 feet, with a circumference of 27 inches. Another species is said to be 3 feet in circumference. Oldham sent home six species of Bamboo from Formosa; and several are found on the continent of China and in Hong Kong, which has one or two species peculiar to itself. The Sandwich Islands produce a new species of *Schizostachyum*, collected by the botanists attached to Wilkes's expedition; but unfortunately, although the spiculæ are very numerous, not one appears to be quite perfect. Another species, of the same genus probably, but in leaf only, is found in several of the Polynesian Islands, as I have seen specimens from the Feejee Islands, Samoo, and Tahiti. Several species are found in the Philippine Islands, the few that I have seen flowers of being berry-bearing Bamboos.

In the whole extent of North America, north of Mexico, there is only one species of uncultivated Bamboo, namely *Arundinaria macrosperma*. In all Europe there is not one native species; and, as mentioned elsewhere, from the vast continent of Africa, only one native species, in flower, is known in herbariums.

One fact in the distribution of the curious species *Pseudostachyum polymorphum*, "Purphok" of Sikkim, is interesting, as Griffiths mentions that it was found in Upper Assam, associated always with the Tea-plant.

Hooker states that "Pao," *Dendrocalamus edulis*, has a very marked limit in elevation, ascending to 4000 feet, where it abounds, flowering yearly, after which it is succeeded by "Poyang" (*Cephalostachyum capitatum*) and "Prang" (*Arundinaria Hookeriana*). The latter, according to Hooker, ascends to 6000 feet and upwards, and produces seed abundantly. The fruit, a dark long grain, like rice, is boiled and made into cakes or into beer.

In the description of the genera and species, I have followed the plan adopted by Hooker and Thomson in the 'Flora Indica;' namely, after the name of the plant I have given as short a diagnosis as possible, followed by the synonymy and the habitats of the plant. I have then given a full description in Latin, and added a few remarks, occasionally, in English as to the habits and uses of the plants, and any remarkable peculiarities in structure, &c. I have used Latin as far as possible, as I was much struck by the remarks of several foreign botanists at the recent botanical congress in London, who complained that the English botanists used too much of their own language in modern systematic works on botany. I have, in many instances, added the native names of the various species, as I have been requested to do so; but I would observe that I consider them very uncertain; and indeed I find that the generic name even is given very differently by collectors in the same country: for instance, with collectors in Java, Horsfield and Harskaal, Rumph and Blume, all use different Javan words for the Bamboo generically. Dr. Hooker states that a dozen kinds of Bamboo are

known to the Lepchas by different names, and that in Khasiya the natives enumerate fourteen different kinds, the names of which are detailed at p. 268 of the second volume of the 'Himalayan Journals.' Most of these I have been able to identify with scientific names. With such careful observers as Hooker and Thomson these native names are of great value; but apparently "non cuique datum" with similar care and facility to express native sounds in European languages.

A large number of Bamboos are now in cultivation, and perhaps twenty species at Kew alone. I am informed there are at least fifty in Paris. Few of these, perhaps of *Arundinaria* only, are hardy in England, or even in the warmer parts of Ireland. Dr. Moore mentions, in the 'Treasury of Botany,' "that several brakes of *Arundinaria falcata* were planted in the county of Cork, in 1848, and that, in ten years, the canes had reached a height of from 16 to 20 feet, being about a foot in circumference at the base. The joints of the stems were nearly of equal growth, and owing to this regularity presented a curious appearance, to those particularly who had not seen tropical vegetation." A fine plant of *Guadua latifolia* is stated to be growing in the Botanical Gardens at Berlin.

There is a specimen preserved in the British Museum of *Bambusa vulgaris*, which is stated to have grown forty feet in forty days at Chatsworth, the noble seat of the Duke of Devonshire.

I have throughout this paper made considerable use of Ruprecht's excellent memoir on Bambuseæ in the Russian 'Transactions' already referred to, but have in all cases marked with " " any paragraphs which I have copied verbatim.

BAMBUSACEÆ

Monographice descriptæ Auctore Colonel WILLIAM MUNRO.

BAMBUSACEÆ, Kunth in Mém. du Mus. xi. 75 (1815); Rœm. et Sch. Syst. Veg. ii. 850 (1817); Link in Hort. Berol. ii. 308 (1833); Trinius in Act. Acad. Cæs. Petrop. ser. vi. Sc. Nat. vol. i. 613 (1835); Steud. Syn. 329 (1855); Miquel in Fl. Ind. Bat. iii. 360 (1855), et in Ann. Mus. Lugd. Bat. ii. 284 (1866). BAMBUSEÆ, Nees in Agrost. Bras. 520 (1829); in Linnæa ix. 461 (1834); in Lindl. Nat. Syst. 2nda edit. 383 (1836); in Fl. Afr. Aust. 460 (1841); Ruprecht in Act. Acad. Cæs. Petr. ser. vi. Sc. Nat. vol. iii. 2nda Part. p. 90 (1840). *Bambusineæ*, Agardh, Aph. 153 (*fide* Nees). *Festucaceæ*, Subtribus II. *Bambuseæ*, Endl. Gen. 102. *Festuceæ*, Subtribus *Bambusidæ*, Lindl. in Veg. King. 3rd ed. 116 (1853). Festucacearum genera, Kunth in Enum. 426 (1833).

Gramina fruticosa vel arborescentia, *culmo* nunc excelsissimo, 120-pedali et ultra, nunc alte scandente, nunc humili, pedali, fistuloso vel raro fere solido, sæpissime ad nodos ramosissimo, spinoso vel inermi. In nonnullis e nodis culmi inferioribus "multæ fibrillæ lignosæ progerminant, quarum inferiores, veræ radices, in terram intrant, superiores spinas, bene dictas 'horridas,' mentiuntur." In plurimis speciebus in culmorum vetustiorum cavitate concretiones siliceæ, *Tabasheer* dictæ, inventæ sunt, sed nunquam in sectione "*Triglossæ*." Iterum in multis locis culmi vel turiones (surculi) tam numerosi sunt ut sylvulas vel etiam sylvas densas fere impenetrabiles constituant.

Folia præ plantæ statura minora, omnia nisi in *Platonia* basi articulata, sæpe cito decidua, interdum *venulis transversis* impressis conspicue *tessellata*.

Vaginæ sæpissime apice fimbriatæ, *ligula* semper præsente, nunc brevi, nunc longiore et quandoque *fimbriis* ciliata.

"*Inflorescentia*: panicula perraro valde composita, sæpius contractior et depauperata, denique in quibusdam ad formam racemi aut spicæ (in aliis verticillatæ in aliis simplicis) quin ad pedunculum monostachyum redacta" (Nees.)

Spiculæ multifloræ vel paucifloræ vel sesquifloræ, nunquam unifloræ. Nisi in subsectione "*Arundinariæ*" omnium flosculi inferiores 1 vel plurimi, abortivi, univalves, sæpe glumas referentes. Interdum quasi in *Paniceis* spiculæ deorsum tantum, in plerisque quasi in *Arundineis* quibusdam sursum deorsumque, in subsectione "*Arundinariæ*," quasi in *Festuceis* plerisque, sursum tantum imperfectæ.

Palea inferior semper plurinervis, superior 2–6- plurinervis, carinata vel ecarinata, interdum (rarissime) deficiens.

Squamulæ typice 3, interdum plurimæ, abortu 2 vel nullæ.

Stamina 3–6 vel plurimæ, filamentis basi liberis vel monadelphis.

Styli plerumque ima basi conjuncti, vix unquam indivisi, sæpissime 2–3–4-fidi.

Caryopsis libera vel in sectione "*Bacciferæ*" perigynio arcte inclusa.

Bambusaceæ, ob characteres supra enumeratos, meo sensu, ab omnibus aliis graminum tribubus bene distinctæ sunt.

Genera *Bambusacea* in sectiones tres dividua sunt.

1. Triglossæ, Link. in Hort. Berol. i. 248 (1827); Nees in Agros. Bras. 520 (1829). *Arundinariæ*, Nees in Linn. ix. 466 (1834), et in Lindl. Nat. Syst. et in Fl. Afr. Aust. 463, Rupr. *l. c.* 111, Steud. Syn. 331, Miquel. *l. c.* 361.

Culmus semper inermis, fistulosus, teres vel in "*Phyllostachy*" semiteres, sæpissime fruticosus, vix arborescens, sæpe scandens, e nodis ramosissimus, interdum nanus, *Tabasheer* nunquam fundens: in *Platonia* tantum herbaceus enodosus. *Panicula* in multis depauperata, simpliciter racemosa vel fere spicata, etiamve subrotunda capitulum referens, in aliis thyrsoidea decomposita, amplissima effusaque; sæpissime basi nuda, interdum vagina folii terminalis (e. g. *Merostachys*) vel foliis ipsis (in sect. *Rettbergia, Chusqueæ*) vel spatha vel bracteis perpaucis (e. g. *Thamnocalamus* et *Phyllostachys*) quasi involucrata: in plurimis terminalis *i. e.* ex apice ramorum vel ramulorum foliiferorum egrediens; in perpaucis (*Arundinariis* quibusdam et *Thamnocalamo*) culmi floriferi et foliiferi discreti sunt. *Spicula* pluriflora vel raro sesquiflora, in subsectione prima sursum, in aliis vel deorsum vel utrinque imperfecta. *Glumæ* ut plurimum paucinerviæ, interdum minimæ vel obsoletæ, nunquam gemmiparæ, sæpe consistentia et colore flosculis perfectis alienæ. *Palea* superior semper bicarinata. *Stamina* 3, basi libera, connectivo nunquam elongato. Squamulæ 3 semper adsunt. *Stylus*, plerumque cito, supra basin 2–3-partitus. *Caryopsis* ovalis oblonga aut lineari-oblonga, sulco laterali notata, scutello extus conspicuo.

Gramina subsectionis primæ, *Arundinariæ*, in hemisphærio utroque; omnia alia hujus sectionis tantum in occidentali crescunt.

Nees has principally trusted to the form of the upper palea, which he describes as compressed and boat-shaped, to distinguish this section from true Bamboos, in which, he says, the upper palea is depressed and broader at the back. I, however, do not find this distinction of sufficient value, as both forms are found indiscriminately in the upper palea of all the three sections. Link describes *Triglossæ* as having 3 stamens, and spiculæ with 1 or 2 bracts at the base, and thus distinguished from *Bracteifloræ*, which have 6 stamens and several bracts. Grisebach, at p. 529 of the 'Flora of the British West-India Islands,' includes 3 genera of this section (*Triglossæ*), namely

Arthrostylidium, *Chusquea*, and *Platonia*, in *Bromeæ*, in consequence of the "stigmas projecting laterally from the flower." In the numerous specimens I have examined I have never observed any tendency to such a structure, as I understand it; nor is there any represented in the numerous dissections contained in the plates attached to Ruprecht's memoir.

2. Bambuseæ veræ, Nees in Agros. Brasil. 531 (1829); in Linnæa, *l. c.* 465; in Lindl. Nat. Syst. *l. c.*, in Fl. Afr. Aust. *l. c.* 461; Miquel, *l. c.* 361. *Bracteifloræ*, Link. Hort. Berol. i. 249 (1827), *partim.*

Culmus spinosus vel inermis, crassus, fistulosus, rarissime solidus, teres, arboreus, elatus, vel raro suffruticosus, nunquam scandens, non raro "Tabasheer" fundens. *Inflorescentia*, vel scapus radicalis (*Bambusa Balcooa*, teste Roxb.), vel panicula vasta culmum interdum prælatum sæpe spinescentem foliis denudatum terminans, ramosa et ramosissima, ramis simpliciter vel composite spicatis vel laxiusculis, adjectis rarissime hinc et inde ramulis foliiferis; vel, ut in *Nasto*, *Guaduis* quibusdam et paucis aliis, panicula ramorum terminalis subsimplex spiculis perpaucis pedicellatis vel sessilibus. *Spicula* pluriflora, sæpe multibracteata, sursum deorsumque imperfecta, interdum biformis, rarissime dioica. *Glumæ* multinerviæ, inferiores, nisi in *Nasto*, fere semper gemmiparæ; omnes flosculis inferioribus sæpe plurimis sterilibus unipalcaceis simillimæ. *Palea* superior bicarinata vel dorso rotundata ecarinata. *Stamina* typice 6, filamentis basi liberis vel monadelphis, antherarum connectivo vel obtuso vel apiculato. *Squamulæ* typice 3, abortu 2, vel raro plane deficientes. *Stylus* vel brevis et brevissimus cito trifidus vel basi plus minus longe simplex et apice tantum 2–3-fidus. *Caryopsis* ovalis vel oblonga vel (præcipue in *Oxytenanthera*) anguste lineari-oblonga, sulco longitudinali notata, scutello extus visibili. *Pericarpium* a semine non distinguendum.
Gramina hujus sectionis in utroque hemisphærio crescunt.

Link's name of *Bracteifloræ* for this section claims precedence in point of date; but it includes all the species both of this section and the following one, and therefore I thought I was justified in adopting Nees's name. Link, morever, does not use his own name in his amended classification of Gramineæ in the 2nd volume of the 'Hortus Berolinensis,' published six years after the first. In this last enumeration he only uses one word, *Bambusaceæ*, to include the whole tribe of Bamboos.

3. Bacciferæ, Munro.

Culmus inermis (an semper ?), fistulosus, rarissime solidus, teres, interdum arboreus elatus, interdum suffruticosus, sæpe scandens, raro *Tabasheer* fundens. *Inflorescentia* vel panicula ampla decomposita, laxa, e. g. *Pseudostachyum* et *Dinochloa*, vel spiculis secus ramos ramulosque in verticillos densissimos congestis, e. g. *Dendrocalamus*, vel spiculis in spicas compositas elongatas basi longe bracteatas aggregatis, e. g. *Melocanna bambusoides*, vel capitulum densum terminale foliis supremis basi dilatatis suffultum, e. g. *Cephalostachyum capitatum*, vel panicula subsimplex terminalis paucipiramia interdum fere spiciformis, e. g. *Beesha* et *Schizostachyum Blumii*. *Spicula* basi sæpe valde composita vel eximie prolifera, ultima (vera) sæpe pauciflora flosculis 1–2 perfectis, in *Teinostachyo* et *Dendrocalamo* multiflora. *Glumæ* multinerviæ, inferiores sæpissime gemmiparæ. *Palea* superior raro deficiens, e. g. *Schizostachyum Blumii*, sæpissime involutissima et non raro ecarinata, sæpe apice bimucronata. *Stamina* 6, vel *plurima*, e. g. *Beesha*, basi libera, connectivo obtuso vel apiculato. *Squamulæ* typice 3, interdum plurimæ, nunc deficientes. *Stylus* basi semper longe simplex, in perigynii rostro arcte inclusus, demum 2–3-fidus stigmatibus sæpe revolutis. *Fructus* interdum maximus, *bacciformis* vel *pomiformis*, in perigynio inclusus, hinc scutellum extus non visibile.
In hemisphærio orientali tantum genera hujus sectionis obvia sunt.

Sectio I. Triglossæ. Confr. supra, p. 11.

Conspectus Generum.

Subsectio I. Arundinariæ. Spiculæ sursum imperfectæ. Stylus 2–3-fidus.

Culmi teretes. Glumæ fere semper paucinerviæ. Stylus *cito* supra basin 2–3-fidus.

Folia venulis tranversis nullis vel conspicuis. Inflorescentia sæpe simplex vel raro composita, ramis ultimis nunquam basi bracteis longis velatis — 1. *Arundinaria.*

Folia venulis transversis inconspicuis. Inflorescentia panicula ramosissima ramis ultimis basi longe bracteatis . . . . . — 2. *Thamnocalamus.*

Culmi semiteretes. Glumæ multinerviæ. Stylus longe supra basin 3-fidus.

Folia venulis transversis conspicuis. Paniculæ ramis alternis basi bracteatis, glumis apice foliaceis imbricatis . . . . . — 3. *Phyllostachys.*

Merostachys would be placed in this subsection by such authors as consider the two lower barren flowers to be glumes.

Subsectio II. Arthrostylidiæ. Spiculæ sursum deorsumque imperfectæ. Stylus fere ad basin bifidus.

Venulis transversis nullis. Spiculæ multifloræ.

Spiculæ fere cylindricæ, pedicellatæ vel sessiles, in racemo simplici vel paniculato dispositæ . . . . . — 4. *Arthrostylidium.*

Spiculæ compressæ, in panicula ramosissima laxe divaricata . . . — 5. *Aulonemia.*

Venulis transversis subtus prominulis. Panicula subspicata.

Spiculæ 2–3-floræ glumis obsoletis . . . . . — 6. *Merostachys.*

Subsectio III. Chusqueæ. Spiculæ deorsum imperfectæ, 3-floræ. Stylus cito bifidus.

Culmus nodosus, foliis angustis basi articulatis . . . . . — 7. *Chusquea.*

Culmus herbaceus enodosus, foliis latis basi inarticulatis . . . . — 8. *Platonia.*

The structure of the spiculæ in these two genera approaches very closely to that of Paniceous grasses; and, what is still more remarkable, the inflorescence of several species both of *Chusquea* and *Platonia* bears such a great resemblance to certain species of *Panicum* that they might very readily be mistaken for them by casual observers.

1. Arundinaria.

Michaux, Fl. Bor.-Amer. i. 74 (1803). *Miegia,* Pers. Syn. Pl. i. 101 (1805). *Ludolfia,* Willd. in Berl. Verh. (1808), 320. *Triglossum,* Fisch. in Catal. Hort. Gorenk. (1812). *Macronax,* Rafin. in N. Y. Med. Rep. v. 350.

Spicula sursum imperfecta, intra glumas breve pedicellata, 3–5–12-flora, rhachilla articulata, flosculis imbricatis distichis distantibus (nisi 1–2 terminalibus) tabescentibus, *omnibus bipaleaceis hermaphroditis* vel rarissime infimo masculo. *Glumæ* valde variabiles, acutæ vel obtusæ, interdum distantes, ut plurimum paucinerviæ, inferior raro abortu deficiens, superiore semper brevior. *Palea* inferior acuminata vel acuto-mucronata, concava, multinervia, glabra vel hirsuta, membranacea, superiorem bicarinatam dorso anguste canaliculatam æquans vel superans. *Stamina* 3, brevia. *Squamulæ* 3, conspicuæ, membranaceæ, ovatæ vel lanceolatæ, ciliatæ, acutæ vel obtusæ. *Stylus* basi integer cito in stigmata 2–3 pilis simplicibus plumosa divisus. *Caryopsis* ovalis vel oblonga vel lineari-oblonga, teretiuscula, postice sulco profundo notata.

Gramina cosmopolitana, culmo tereti, suffruticosa, raro arborescentia, nunquam nisi in *A. distante* scan-

dentia; ramis interdum ad nodos fasciculatis vel fere verticillatis. Folia plerumque parva *venulis transversis* nunc *obscuris* nunc *quam maxime conspicuis tessellata*. Inflorescentia plerumque *terminalis*; interdum *simplicissima*, racemo spiculis 1–4 fere spicato; interdum *racemus compositus decompositusque* laxus amplissimus axillis glandulosis; interdum *ramuli floriferi basi fere aphylli*, ad nodos dense fasciculati vel verticillati sunt, horum ramulorum pauci proliferi et hinc quasi compositi sunt, sed *ramulis ultimis nunquam basi longe bracteatis*. Denique in nonnullis speciebus culmi floriferi et florigeri diversi sunt.

The greatest caprice has been shown in the alteration by successive botanists of the name of this genus, especially when it is considered that no doubt was entertained by them of the identity of the original species, *Arundinaria macrosperma*. Michaux originally called it *Arundinaria*; and Persoon, writing very shortly afterwards, quotes Michaux's name, but alters it to *Miegia*. This name could not stand, because it had been previously, in 1789, adopted by Schreber for quite a distinct genus of grasses. Consequently Willdenow altered the name, in 1808, to *Ludolfia*, assigning as a reason for so doing the great resemblance which the original word *Arundinaria* bears to Linnæus's genus *Arundo*. Smith, in Rees's 'Cyclopædia,' adopts the same argument. Fischer, an excellent botanist, in 1812, created the generic name *Triglossum*, of a single spicula of which he gives a very fair drawing in 'Catalogus Horti Gorenkis.' He says the genus is distinct from *Ludolfia* in having all the flowers hermaphrodite, with 3 squamulæ. Both these characters are especially peculiar to *Arundinaria*, and the drawing is evidently that of a spicula of *Arundinaria macrosperma*.

Conspectus Specierum.

Sect. I. *Inflorescentia terminalis, i.e.* rami ramulive basi foliiferi apice florigeri. Folia venulis transversis *valde conspicuis tessellata*. Stylus cito 3-*fidus*. Spiculæ multi- (plus quam 5-) floræ.

Panicula simplex semelve composita, plerumque racemosa, *paucispiculata*.

Vaginæ apice *fimbriatæ*.

Arborescens vel suffruticosa, foliis $\frac{1}{3}$–2 poll. latis, panicula depauperata, spiculis longis 1–3–5, *palea inferiore* plus minus, semper margine, *hirsuta* . . . . . 1. *A. macrosperma*.

Suffruticosa, foliis maximis 6 lin. latis, *panicula 7 poll. longa*, radiis longissimis, *palea* inferiore *subglabra* . . . 2. *A. radiata*.

Suffruticosa, foliis 4–6 lin. latis, *panicula* 2–3 poll. longa, rhachi *glabra*, *palea* inferiore *fere glabra* vel hirsutiuscula . . 3. *A. racemosa*.

Vaginæ *efimbriatæ*. Suffruticosa, foliis 10–11 lin. latis, panicula 2–3 poll. longa, rhachi pubescente, palea inferiore subhirsuta . 4. *A. Kurilensis*.

Panicula composita, ramis *multispiculatis* densis adpressis, inexpansa. Palea inferiore fere glabra . . . . . 5. *A. Japonica*.

Folia *tessellata*, sed venulis transversis *minus conspicuis*, *margine membranaceo*. Stylus cito 2-*fidus*.

Panicula decomposita expansa axillis plus minus glandulosis.

Internodia culmi apice vix hirsuta, foliis angustis, vaginis hirsutis, spiculæ 2–3–5-floræ, fere glabræ . . . . . 6. *A. Wightiana*.

Internodia apice glabra, foliis latis, vaginis glaberrimis, spiculæ 3–4-floræ, glabræ . . . . . 7. *A. longiramea.*
Internodia pilis reversis hirsuta, spiculæ 5–8-floræ, pubescentes vel hirsutæ . . . . . 8. *A. floribunda.*
Internodia apice fusco lanata, spiculæ 5–6-floræ fere glabræ . . 9. *A. Griffithiana.*

Folia *tessellata* venulis transversis *valde conspicuis, margine cartilagineo.*
Stylus cito 2-*fidus.* Panicula *decomposita* . . . . . 10. *A. Walkeriana.*

Folia venulis transversis nullis vel obsoletis.
Panicula simplex, semper terminalis.
Spiculæ *solitariæ* paucæve *nutantes* 2 *poll. longæ* . . . . . 11. *A. glaucescens.*
Spiculæ 5–6, in *racemo* terminali, 4–5 *poll. longæ*. . . . . 12. *A. macrostachya.*
Spiculæ 3–4 *sessiles* fere *spicatæ* 8–12 *lin. longæ* . . . . . 13. *A. distans.*
Panicula vere simplex (spiculis 2–5), vel in ramulis foliiferis terminalis, vel basi aphylla circa nodos dense fasciculata . . . . . 14. *A. verticillata.*
Panicula semel bisve composita, in ramulis fasciculatis, terminalis.
Panicula ramis pedicellisque brevibus, crassis. Spiculæ 3-floræ . 15. *A. debilis.*
Panicula ramis pedicellisque longis, tenuibus. Spiculæ sub 4-floræ pubescentes, glumis longissime acuminatis . . . . . 16. *A. acuminata.*
Panicula ramis 3–4 longis demum repandis. Spiculæ 6–11-floræ, glumis valde inæqualibus vix acutis . . . . . 17. *A. Trianæ.*
Panicula amplissima decomposita. Folia lata ciliis vaginæ longissimis. Stylus cito trifidus . . . . . 18. *A. amplissima.*

Sect. II. *Culmi foliiferi* et *floriferi distincti,* hinc *inflorescentia* totum culmum floriferum occupat, ramulis basi aphyllis circa nodos fasciculatis, vel simplicibus vel proliferis compositis.
Folia, venulis transversis nullis vel obsoletis, angusta.
Folia subtus circa costam pilosa. Glumæ longæ spiculam sæpe subæquantes 19. *A. falcata.*
Folia subtus glabra. Glumæ vix dimidium spiculæ attingentes . . 20. *A. Khasiana.*
Folia, venulis transversis, subtus præcipue, prominulis, 11–12 lin. lata.
Spiculæ 2–3-floræ. Folia sub 6 lin. lata . . . . . 21. *A. intermedia.*
Spiculæ sesquifloræ. Folia 6–12 lin. lata . . . . . 22. *A. Hookeriana.*

In hoc conspectu, *Arundinariæ* solæ quarum flores noti sunt inclusæ. Species statu foliifero tantum notæ ad calcem generis locatæ sunt.

1. A. MACROSPERMA, Michaux, Fl. Bor.-Am. i. 74. Culmi nodis hirsutis vel in var. β. subglabris, foliis $\frac{1}{3}$–2 poll. latis, tessellatis, spiculis compressis $1\frac{1}{2}$–3 poll. longis, 5–8–15-floris plus minus hirsutis.

a. arborescens, culmus 10–20–35 (fide A. Gray)-pedalis, ramulis numerosis floriferis, fere spicigeris, sæpe fasciculatis, foliis $1\frac{1}{2}$–2 poll. latis, Rœm. et Sch. Syst. Veg. ii. p. 846; Mant. ii. 465, iii. 670; Nees, Agr. Bras. 526; Kth. Enum. 426, var. β, et Suppl. tab. 33. fig. 4; Ruprecht, *l. c.* 112, tab. i. fig. 2; Trin. *l. c.* 622; A. Gray, Man., 2nd edit. 568; Steud. *l. c.* 334. *A. gigantea,* Chapm. in Fl. S. U. States, 561; Schult. (fide Steudel). *Arundo gigantea,* Walt. Carol. 81 (1785). *Miegia macrosperma,* Pers. Syn. i. 102; Pursh, Fl. Am. Sept. i. 59. *M. gigantea,* Nutt. Gen. N. Amer. p. 39. *M. maritima,* Willd. (fide Steudel). *M. arundinacea,* Torrey, MS. et herb. *Nastus macrosperma,* Raspail, Ann. Sci. Nat. v. 458, t. 8. fig. 1. *Ludolfia macrosperma,* Willd. in Mag. *l. c.* 320; Dietr. Spec. i. 24; Spreng. Syst. i. 233. *Festuca grandiflora,* Lam. Illustr. i. 191. *Macronax,* Rafinesque, *l. c.*

β. *suffruticosus,* spicis vel racemis paucioribus interdum solitariis culmum terminantibus, foliis $\frac{1}{3}$–1 poll. latis. *Arundinaria tecta,* Muehl. Desc. 491 (1817); Schult. Mant. ii. 465; Ruprecht, *l. c.* 111, tab. ii.

fig. 1 *a*, *β*, *γ*, *δ*; Chapman, *l. c.* 561; Steudel, *l. c.* 334. *A. macrosperma*, var., Nees, Kunth, A. Gray, *l. c.*, P. de B. Agrost. p. 144, tab. xxv. fig. 7. *Arundo tecta*, Muehl. *l. c.* 81. *Miegia macrosperma*, Nutt. Gen. 39. *Miegia pumila*, Nutt. fide Ruprecht, *l. c.* et herb. *Ludolfia tecta*, Dietr. *l. c.* *Triglossum bambusinum*, Fisch. *l. c.*

Hab. America sept., frequens. Vidi specimina e Philadelphia!; Florida!, *Chapman*; Kentucky!, *Short*, *Carey*; New Orleans, *Drummond*, 474!, *Elliott*; Texas! *Lindheimer*; Georgia!, Arkansas! *Nuttall*, *Elliott*, *Schweinitz*; Carolina! *Frazer*. In Europa culta.

Culmus arborescens vel suffruticosus, nodis plerumque hirsutis, in var. *a* ramis 3–4-pedalibus. *Folia* lanceolata basi rotundata in petiolum attenuata, nervis secundariis 6–14; venulis transversis crebris, 4 lin.–2 poll. lata, 3–7 poll. longa, marginibus serratis, undique scabra, dorso pubescentia. *Vaginæ* internodiis breviores, superiores subsemipedales, striatæ, sulcatæ, ore ligulatæ et appendiculato-fimbriatæ, uno margine longe ciliatæ, ligula truncata hyalina lacero-ciliata, fimbriis rigidis 1–3-linearibus scabris deciduis. *Panicula* subracemosa, pauciflora, spiculis 1–5, vel in culmo solitaria vel in ramulis plurimis, quasi paniculatis, ad nodos fasciculatis, terminalis. *Spiculæ* compressæ, lineari-lanceolatæ, 10 lin.–3 poll. longæ, 5–8–15-floræ, sæpe dense pubescentes, raro subglabræ, semper margine plus minus hirsutæ membranaceæ nervosæ. *Glumæ* valde variabiles, inferior $1\frac{1}{2}$–3-lin. longa, acuta vel obtusa, interdum deficiens, superior 3–8 lin. longa, flosculum proximum vel subæquans vel duplo et etiam 3-plo brevior. *Palea* inferior, 9–11-nervia, lanceolata, acuminata, margine longe fimbriata, transverse venulosa, superiore apice bimucronata paulo longior. *Squamulæ* inæquales, lanceolatæ, basi coloratæ, venosæ, margine ciliatæ vel fere glabræ. *Ovarium* apice attenuatum in stylum, basi integrum, cito in stigmata 3 divisum. *Caryopsis* oblonga.

This grass certainly varies very much in form; and there is a very great difference in the appearance of the small purplish-coloured nearly glabrous spiculæ of the variety called "*colorata*" by Ruprecht, compared with the large pale-coloured densely pubescent spiculæ, nearly 2 inches long, generally found in dwarf specimens, terminated by a single panicle. Intermediate forms, however, abound; and I quite coincide with Pursh, Nuttall, and A. Gray in considering that all these forms belong to one and the same species. This variation in form will to a certain extent account for the fact that this one species bears no less than nine different generic and nineteen specific names. I have already referred to the needless alterations that have been made in the generic name. Carey mentions that this grass, which was once common in Kentucky, has become now nearly extinct there.

2. A. RADIATA, Ruprecht, *l. c.* 115, tab. xv. fig. 9. Culmi nodis glabris, foliis tessellatis, vaginis fimbriatis pubescentibus, panicula spithamæa radiis solitariis longissimis monostachyis, gluma superiore flosculo infimo plane simili, Steud. *l. c.* 335.

Hab. In sylvis umbrosis Brasiliæ, *Riedel*, s. v., *Ruprecht*.

"*Culmus* erectus ramis ad nodos glabris ramulos simplices foliiferos apice floriferos emittentibus. *Folia* lanceolata, maxima 4 lin. lata, 5 poll. longa, basi rotundata, subsessilia, læviuscula, viridia, nervis secundariis subobsoletis, utroque latere 5–6, venulis transversis valde pellucidis inferne prominentibus distantibus. *Vaginæ* pubescentes sulcato-striatæ, ore fimbriatæ, fimbriis 2-linealibus. *Panicula* (juba) spithamæa, radiis solitariis longissimis erectis monostachyis. *Spiculæ* sub 7-lineales, teretiusculæ, subglabræ, 4–5-floræ. *Gluma* superior flosculo infimo plane similis. *Flosculi* brevissime pedicellati, subglabri. *Palea* inferior lineari-obovata, apice longe mucronata vel subulata, 5-nervia; superior minima, hebetata, nonnisi in flosculis 2do, 3tio, et 4to inventa."

I have not seen any specimen of this; and Ruprecht states that the specimen he saw was too young to have any of the genitalia perfect. If the lower flower has only one palea, the plant would belong to *Arthrostylidium*, from which, however, the tessellated leaves would appear to keep it distinct.

3. A. RACEMOSA, Munro. Culmi internodiis apice scabris; foliis tessellatis; vaginis fimbriatis, inter strias pubescentibus, demum glabrescentibus; panicula 2–3 poll. longa, rhachi glabra, spiculis subpollicaribus, 4–5-floris.

Hab. Himalayas, Darjeeling, Birch Hill! 6000 ped. s. m.; Sinchul! 8000 ped.; Sikkim, Islumbo Pass! 11,000 ped. *Thomson,* Mainom! 6000–8000 ped. ("Pummoon" incolis); E. Nepal, Yalloong! 10,000 ped. ("Pat-hioo" incolis), *Hooker*: v. s.

Culmus teres, 2–4-pedalis, pallide cæruleus, internodiis sæpe vix bipollicaribus, apice scabris vel scabriusculis, ramulis foliiferis florigerisque ad nodos fasciculatis. *Folia* lineari-lanceolata, basi obtusa vel sæpe in petiolum brevem attenuata, 4–6 lin. lata, 2–4 poll. longa, apice setaceo acuminata, nervis secundariis utrinque 3, venulis transversis supra subtusque conspicuis; juniora subtus pilis longis hirsuta, demum glabra. *Vaginæ* striatæ, inter strias primum pubescentes, demum glabræ, membrana brevi ciliatula terminatæ, ligulatæ, oreque ciliis paucis longis fimbriatæ. *Panicula* simplex, rhachi glabra in ramulis terminalibus longe exserta; spiculis 3–4; pedicellis angulatis, 1–1½ poll. longis. *Spiculæ* glabræ vel hirsutiusculæ, 4–5-floræ, intra glumas pedicellatæ, subpollicares; rhachillæ articulis hirsutis flosculis fere æquilongis. *Glumæ* valde variabiles, plerumque breves vel brevissimæ, obtusæ vel acutæ, inferior sæpe fere obsoleta. Palea inferior caudato-acuminata sub 9–11-nervis, fusca, margine apicem versus ciliata, sub lente scaberulo-hispida; superior brevior, apice bimucronata, carinis apices versus extus ciliatis. *Squamulæ* vix inæquales, basi venosæ, oblongæ, obtusæ, apice longe ciliatæ. *Stylus* vix ullus, cito in stigmata 3 divisus. *Fructus* maturus linearis, sub 3 lin. longus, apice attenuatus, sulco longitudinali notatus.

This species has very rarely been found in flower; and when in foliage only it is extremely difficult to distinguish it from *Thamnocalamus spathiflorus*, Munr., *Arundinaria spathiflora*, Trin. The best marks of distinction are the roughness of the stem below the nodes, the long points to the leaves, and the membrane at the top of the vagina and below the articulation of the petiole, which is only slightly hairy. The leaves have often long hairs below.

4. A. KURILENSIS, Ruprecht, in Bull. Petersb. viii. (1850) 121. Panicula simplici racemosa, 2–3 poll. longa, rhachi pubescente; foliis tessellatis, 10–11 lin. latis; vaginis efimbriatis.—Steudel. *l. c.* 335.

Hab. Ins. Ouroup Kurilarum, s. v. Ruprecht.

Culmus suffruticosus, 6–8-pedalis et diametro 3 lin., internodiis culmi floriferi 3 poll. longis, ramulis erectis adpressis. *Folia* majora 5 poll. longa, 10–11 lin. lata, basi rotundata, ovato-acuminata, supra glabra, subtus pallidiora, margine fimbriata, nervis secundariis utroque latere 6–7, venulis transversis pellucidis, interstitiis quadratis. *Vagina efimbriata,* quod notatu dignum inter *Arundinarias,* ligula conspicua 1 lin. longa. *Racemus* simplex, 2–3 poll. longus, spiculis 4–5, pedicellis 2–4 lin. longis. *Rhachis hirsuta,* pilis adpressis pallidis, qui in rhachilla fere sericei sunt. *Spicula,* flosculis omnibus nisi infimo delapsis, ½ poll. longa. *Glumæ* pilis adpressis hirsutæ; inferior valde variabilis, sub 1 lin. longa; superior 2–4 lin. longa, basi angustata, apice in mucronem acuminata. *Palea* inferior ovata, 7–9-nervis, costata, superior 3–4 lin. longa, bicarinata. *Stylus* cito in stigmata 3 divisus.

I have not seen any specimen of this plant, and have copied the preceding description from that given in German by Ruprecht in the Transactions referred to above. The plant is said to be commonly called Chup-tatt by the inhabitants, who use it for arrow-heads and several other purposes. It is found in *Ouroup*, one of the Kurile Islands, in 46° N. lat., and is believed to have been introduced from some of the islands still further north, and is therefore probably the most northern species known of the whole family. It is closely allied in some respects both to *A. macrosperma* and *A. racemosa*, from both of which it is distinguished by the absence of cilia to the vaginæ, and from the latter by the hairy rhachis and broader leaves. Ruprecht mentions that he had not seen any perfect spiculæ.

5. A. Japonica, Sieb. & Zucc., MS. apud Steud. *l. c.* 334. Panicula composita, ramis adpressis; spiculis numerosis, 1–2 poll. longis; foliis tessellatis, ½–1 poll. latis, 3–9 poll. longis.—A. Gray in Parry's Exped. 328; Miquel, Prol. Fl. Japon. Annal. Mus. Bot. Lugduno-Batav. ii. 284; *Bambusa Metake* Sieb. et Hort.; *B. mitis* Hort. Paris. var. cult. spiculis 20-floris, 4 poll. longis.

Hab. In Japonia, ins. Kiusiu! ins. Niphon, *Burger*; Simoda! *Williams*; Java (fide *Steud.*). In hortis Europæ cult.! v. s. et v.

Culmus 6–8–12-pedalis, suffruticosus, ramis striatis, glabris, ramulosis, fasciculatis, ramulis inæqualibus infra florentiam pubescentibus, internodiis 2–3 poll. longis, apice glaucescentibus. *Folia* lanceolata, apice setaceo acuminatissima, basi in petiolum brevem attenuata, ½–1 poll. lata, 3–9 poll. longa, marginibus scabris, nervis secundariis utroque latere 4–6, venulis transversis, creberrimis, tessellata, subtus pallidiora vel glaucescentia, glabra vel dense puberulo-scaberula. *Vaginæ* sæpe glaucedine dense adhærente minute puncticulata tectæ, striatæ, coloratæ, apice ciliis perpaucis, cito deciduis, fimbriatæ, ligula conspicua producta coriacea extus subhirsuta. *Panicula* composita, ramis vel multo vel pauco spiculatis, adpressis, plerumque brevibus, angulis villosis vel pubescentibus vel in cultis glabrioribus. *Spiculæ* 2–10–20-floræ, angustæ, sæpe subcylindricæ, 1–4 poll. longæ, rhachillæ articulis brevibus albo hirsutis. *Glumæ* inæquales, lanceolatæ, flosculis breviores; inferior 4–5-nervis, margine interdum ciliata; superior sub 9-nervis, margine glabra. *Palea* inferior sub 15-nervis, lanceolata, dorso convexa, mucronato-acuta, viridis vel colorata serotina fuscescens, sub lente scaberulo-hirsutiuscula, margine glabra; superior interdum æquilonga vel raro multo brevior, depressa, apice bimucronata, bicarinata, carinis conspicue ciliatis. *Squamulæ* 3, longæ, æquales, lanceolatæ, ciliatæ, basi nervosæ. "*Antheræ* defloratæ petaloideo-explanatæ, persistentes vel caducæ" (*Steud.*). *Stylus* cito trifidus, in stigmata 3 elongata. *Ovarium* oblongum, in stylum attenuatum.

This seems to have a range of about 4 (degrees from 32° to 36° N. lat.) in Japan; and I am therefore surprised that I do not find a specimen of it in Kæmpfer's herbarium. It is said to be called Niga-sasa (one of Kæmpfer's names) in the island of Niphon, and Me-take, and Sikah-take in the island of Kiusiu. In the specimens I have seen collected in Japan, the main and partial rhachis are both very hairy; whereas in those cultivated at Kew, where this plant appears to be quite hardy, the rhachis is smooth; and in some of the specimens the lower palea, which is generally 4–5 lines long, becomes nearly an inch long, whilst the upper one retains its usual length. Miquel, in the 'Annales' above referred to, says that, as far as description goes, *Bambusa reticulata*, Ruprecht, does not differ from *A. Japonica*; but I believe Ruprecht's plant to be more closely allied to a broad-leaved state of *Phyllostachys bambusoides*.

6. A. WIGHTIANA, Nees in Linnæa, ix. 482. Panicula decomposita, ramis patulis, axillis glandulosis; foliis tessellatis, margine membranaceo, 4–4½, raro 8 lin. latis; vaginis hirsutis; spiculis 2–8-floris, fere glabris.—Ruprecht, *l. c.* 116, tab. iii. fig. 10.; Steud. *l. c.* 335, non Benth. in Fl. Hong., nec Thw. in Enum. Pl. Zeyl. *A. hispida*, Steud. *l. c.* 335. *A. moliniformis*, Hochst. in Herb. Hohenacker, no. 1282!

Hab. Ind. or: in montibus Nilghiri! *Wight*, no. 213! 1797! *Schmid*! *Hohenacker*! v. s.

Culmus suffruticosus, ad nodos ramosissimus, 6–8-pedalis, crassitie 2½-lineali, internodiis 2–4 poll. longis, apices versus e tuberculis asperis vel glabris, nodis ipsis vix hirsutis, ramulis in fasciculo quam plurimis ½–1 ped. longis, fere omnibus paniculam terminalem gerentibus, 1–2 foliiferis tantum, in his folia majora sunt. *Folia* ovato-lanceolata, acuminata, subtus glaucescentia et sæpe basin versus ad costam glandulosa, plerumque 1½–3 poll. longa, 4–5 lin. lata, raro (in ramulis sterilibus) 8–9 lin. lata, 4–6 poll. longa, basi rotundata vel cuneata brevi-petiolata (petiolo basi subtumido), margine membranaceo scabro vel scaberrimo vel tandem glabrescente, nervis secundariis utrinque 4–6, venulis transversis pallidioribus sat crebris. *Vaginæ* striatæ, sæpe coloratæ, nunc tuberculis hispidæ, nunc glabrescentes (in eodem ramulo), ore ciliis 1–2–3 longis fimbriatæ, ligula elongata vel brevissima. *Panicula* terminalis 4–6 poll. longa, decomposita, effusa, ramis patentibus vel divaricatis, axillis omnibus conspicue glandulosis, ramulis ultimis paucifloris. *Spiculæ* in pedicellis longis vel longissimis, 2–5-floræ, pallidæ vel coloratæ, fere glabræ vel hirsutiusculæ, 4–6 lin. longæ, rhachillæ articulis subclavatis, scabro-hirsutis. *Glumæ* nervosæ, acuminatæ vel obtusæ, apice ciliatæ; inferior plerumque acuto-mucronata, 2–5-nervis; superior basi 7-nervis, acuminata. *Palea* inferior sub 5–7-nervis, mucronata, primo adspectu glabra, sub lente scaberulo-hispidiuscula; superior subæquilonga, apice bicuspidata. *Filamenta* 3, antheris luteis. *Stylus* cito bifidus. *Squamulæ* ovatæ obtusæ vel acutæ (fide *Ruprecht* in icone), margine fimbriatæ, nervosæ.

This species appears to be confined to the Neilgherries, where it covers the outer slopes of the hills to some extent, especially towards Sisparah. *A. Wightiana*, or *Wightii* of the 'Hongkong Flora,' is my *A. longiramea*, and is easily distinguished by its habit, long branches of the panicle, and large very smooth leaves and vaginæ. *A. Wightiana* of the 'Enumeration of Ceylon Plants' is my *A. Walkeriana*, separated from all its allies by the thickened cartilaginous margin of the deeply tessellated leaves.

7. A. LONGIRAMEA, Munro. Paniculæ compositæ vel decompositæ, *ramis* divaricatissimis, *infimis longissimis* (4–8-poll.), pedicellis sæpe 2 poll. longis; foliis usque ad 15 lin. latis, tessellatis; vaginis demum lævissimis; spiculis 3–4-floris, glabris.—*A. Wightii*, Benth. in Fl. Hongk. 434.

Hab. Hong Kong, *C. Wright*! *Hance*, no. 1945! v. s.

"*Culmi*, crassitie pennæ anserinæ, e rhizomate repente oriuntur" (Hance), "ad nodos ramosi" (Wright), internodiis apice glabris. *Folia* lanceolataa cuta, basi subcuneata in *petiolum* brevem *utroque latere rugulosum attenuata*, glabra, subtus pallidiora, majora 6–9 poll. longa, 9–15 lin. lata, minora (infra paniculam locata) 2½–4 poll. longa, 4–6 lin. lata, nervis secundariis utrinque 5–7 inconspicuis, venulis transversis distantibus, præcipue subtus, conspicuis. *Vaginæ* primum striatæ demum lævissimæ, ciliis perpaucis fimbriatæ, ligula brevi. *Panicula* ½–1-pedalis et ultra, ramis glabris simplicibus vel compositis, infimis 4–6 poll. longis, divaricatissimis, axillis glandulosis; pedicellis 1–2 poll. longis, interdum flexuosis. *Spiculæ* 3–4-floræ, glabriusculæ, 6–8 lin. longæ. *Glumæ* glabræ, margine inconspicue ciliatæ; inferior subacuta, membranacea, hyalina, 3 lin. longa, vix carinata, nervis 1–3 utrinque conspicuis;

superior similis, obtusiuscula, 4 lin. longa, carinata, utrinque 3–4-nervis. *Paleæ* glabræ vel apice hirsutiusculæ; inferior membranacea, convoluta, acuta, utrinque nervis 3 validis et 3 tenuioribus ante apicem desinentibus notata, ad basin, *more insolito, biappendiculata*; superior subæquilonga, bicarinata, fere obtusa, apicem versus longe ciliata. *Squamulæ* 3, magnæ, inæquales, duæ majores, lanceolatæ, coloratæ, nervosæ, basi crassæ, apice fimbriatæ. *Stylus* cito bifidus.

This species is confined to Hong Kong. At page 434 of the 'Hongkong Flora.' Bentham states that he had inserted the plant on my authority. I then considered it to be *A. Wightiana*, having only seen a portion of a panicle collected by Wright. I have since seen much better specimens collected by Hance, and find that it is evidently quite a distinct species, for reasons already detailed in describing *A. Wightiana*. Hance's specimens indicate a distinct habit of growth—namely, nearly simple culms springing from a creeping root-stock, terminated by a single long panicle, or bearing large leaves only. Wright, however, mentions in a note that the culms were "branching at the nodes."

8. A. FLORIBUNDA, Thw. in Enum. Ceyl. Plants, 475. Paniculæ decompositæ, ramis plerumque adpressis, foliis 3–7 lin. latis, tessellatis; vaginis primum pilis longis hirsutis; spiculis 4–6–8-floris, pubescentibus.

Hab. Ceylon, Maturatte Dist! 5000 p. s. m., *Thwaites*, C.P. 2624! v. s.

Culmi ad nodos ramulosi, erecti, suffruticosi, 2–5-pedales, internodiis 2–4 poll. longis, apicibus pilis reversis hirsutissimis. *Folia* lanceolata, acuminatissima, glabra, margine serrata, nervis secundariis utroque latere 3–4, venulis transversis sat crebris et conspicuis tessellata, plus minus in petiolum basi subtumidum attenuata. *Vaginæ* striatæ, sæpe, et præsertim inferiores, pilis longis bulbosis hispidæ, tandem glabrescentes, margine sæpe coloratæ, apice ciliis longis plurimis fimbriatæ, ligula brevissima. *Panicula* in ramulis culmi terminalis, 4–6 poll. longa, ramis plerumque adpressis, rarissime subexpansis, glabris, angulatis, in axillis parce glandulosis. *Spiculæ* in pedicellis inæqualibus (brevibus vel longis), 4–6–8 floræ, pollicares vel ultra, subsericeo pubescentes. *Glumæ* inæquales, acutæ, nervosæ, apice ciliatæ; inferior minor, 2 lin. longa. *Palea* inferior $3\frac{1}{2}$ lin. longa, adpresse pubescens, nervosa, subulato-acuminata; superior subæquilonga, apice bicuspidata. *Squamulæ* 3, inæquales; 2 oblique-lanceolatæ, basi coloratæ, nervosæ, margine ciliatæ; tertia angustior vix nervosa, ciliata. *Stylus* cito bifidus in stigmata 2 pulcherrime plumosa. *Fructus* maturus purpureus, $1\frac{3}{4}$ lin. longus, linearis, apice hirsutiusculus, residua styli bifidi basi coronatus.

This approaches very closely indeed to *A. Wightiana*, and has the same habit of growth. It is most easily distinguished by the generally adpressed branches of the panicle, and the much longer, almost silkily pubescent spiculæ, containing generally 6–8 flowers.

9. A. GRIFFITHIANA, Munro. Paniculæ ramis brevibus demum reflexis axillis hirsuto-glandulosis, pedicellis plerumque brevissimis; spiculis 5–6-floris, fere glabris; foliis membranaceis, tessellatis, setaceo longe acuminatis; internodiis culmi apice lanatis, nodis ipsis interdum spinosis et barbatis.

Hab. Ind. or. in mont. Khasia., Moflong! *Griffith*! (Assam Dep. no. 39), *Hooker*! v. s.

Culmus fistulosus, 4–6-pedalis, internodiis 2–5 poll. longis, striatis, sulcatis, apice fusco-lanatis, cæterum glabris; nodis prominulis, inferioribus sæpe verticillo spinarum cinctis; spathis internodia plus minus superantibus apiculo lanceolato sub 1 poll. longo terminatis, margine longe fimbriatis,

dorso glabriusculis vel basi hirsutis. *Ramuli* ad nodos semiverticillati, superiores (culmi) floriferi fere aphylli, inferiores foliiferi tantum. *Folia* membranacea, glabra, subtus pallidiora, margine tenui-serrata, lineari-lanceolata, longe setacco-acuminata, basi attenuata, 2–6 poll. longa, 4–8 lin. lata, nervis secundariis utrinque 4–5, venulis transversis crebris elevatis tessellata. *Vaginæ* striatæ, dorso glabræ, apice ciliis fimbriatæ, ligula subbrevi extus hirsuta. *Panicula* in ramulis subternis (basi bracteis vel spathulis carinis hirsutissimis vaginatis) ad nodos fasciculatis vel aphyllis vel foliis cito deciduis terminalis, 3–4 poll. longa, ramis paucis brevibus (2–3-poll.) demum refractis, axillis hirsuto-glandulosis. *Spiculæ* intra glumas pedicellatæ, in ramulis basi incrassatis paucæ, plerumque brevissime pedicellatæ, 5–6-floræ, 1–1½ poll. longæ, angustæ, glabræ, rhachillæ fragilis articulis longis clavatis hirsutis. *Glumæ* acutæ, apice scabræ vel hirsutæ, inferior basi 5-nervis, superior longior (4–4½ lin.) 7-nervis. *Palea* inferior acuminatissima, mucrone caduco, 7–8 lin. longa, nervosa, glabra; superior subbrevior, bicarinata, bimucronata, carinis ciliatis. *Squamulæ* longe fimbriatæ, subæquales, vix venosæ. *Stamina* 3, antheris interdum apice *pauci-setosis*, connectivo vix elongato. *Stylus* cito bifidus. *Ovarium* lineari-oblongum, vix rostratum.

This species is quite unlike any other known to me, and is well distinguished by its woolly and occasionally prickly nodes. It is the only one, I believe, in the genus with spinous joints or the hairy points to the anthers described above, although these latter appendages are found in many other genera of Bambusaceæ. It appears to have been only once found in flower—namely, by the Assam Deputation for the examination of the Tea-plant, under Wallich and Griffith. There is a good specimen (leaves only) in the Kew Museum, No. 605, in which the prickly nodes can be very well seen; and some unusually large specimens of the nodes are also preserved in spirits. Hooker, in his 'Himalayan Journals,' vol. ii. p. 291, mentions a wood of "prickly Bamboo" near Moflung.

10. A. Walkeriana, Munro. Paniculæ decompositæ, ramis adpressis, axillis inferioribus glandulosis, superioribus hirsutis; spiculis 3–4-floris, glabris; foliis crassis eximie tessellatis, marginibus cartilagineis fimbriatis; ramulorum sterilium vaginarum ciliis numerosis, plicatis.—*A. Wightiana*, Thw. in En. Pl. Zeyl. p. 444, non N. ab E.

Hab. Ceylon, *Mrs. Walker*, no. 96! 1304! *J. Watson*, 215!; Adam's Peak, *Thwaites*, 429!; Pedrotalagalla! *Thwaites*, 3860! v. s.

Culmus mihi ignotus, internodiis supremis 1½–2 poll. longis, glabris, ramulis plerumque 1–3, interdum plurimis ad nodos fasciculatis. *Folia* ovata acuta, utrinque eximie tessellata venulis transversis creberrimis, apice pungentia, basi rotundata, subito petiolata, 2–4 poll. longa, 5–8 lin. lata, glabra, subtus vix pallidiora, margine cartilagineo pilis longis ciliato, nervis secundariis utrinque 5–6. *Vaginæ* striatæ, glabræ, apice quasi subito transverse abscissæ, in ramulis (sterilibus præcipue), utrinque ciliis pallidis multis plicatis fimbriatæ, ligula brevi. *Panicula* decomposita, 4–5 poll. longa; ramis virgatis, angulatis, glaberrimis; axillis inferioribus glandulosis; superioribus hirsutis; pedicellis, nisi terminali longiore, spiculis brevioribus. *Spiculæ* coloratæ, glabræ, 3–4-floræ, 10–12 lin. longæ, intra glumas breviter pedicellatæ, callo hirsuto, articulis rhachillæ compressis pubescentibus. *Glumæ* vix inæquales, apices versus margine ciliatæ; inferior vix acuta, nervo 1 valido et 4 inconspicuis; superior nervis 3 validis et 4 inconspicuis, acuminata vel fere obtusa. *Palea* inferior *basi pilis stipata*, 9-nervis, nervis plurimis ante apicem evanescentibus, glabra, oblonga acuta et ciliata; superior æqualis, apice obtuso vix bifida, subhirsuta, bicarinata, carinis superne ciliatis. *Squamulæ* 3, membranaceæ, obtusæ, nervis meandrinis basi nervosæ, margine ciliatæ, duæ majores. *Stylus* basi tumidus, in stigmata 2 lata compressa cito divisus. *Ovarium* apice constrictum.

The thickened cartilaginous margin of the leaves distinguishes this from all the species previously described. In this respect some of the species, of which the leaves only are known, approach it, and especially one which I have described as *A. densifolia*, and which, being, as it is, a native of Ceylon, may possibly be a peculiar state of this plant—although it appears to me to be well distinguished by its remarkably narrow small leaves, in which the tessellation is sometimes very indistinct.

** Folia venulis transversis *nullis* vel *inconspicuis*.

11. A. GLAUCESCENS, P. de B. Agros. 144 & 152. "Spica terminali simplici, spiculave solitaria bipollicari nutante, 6–9-flora; foliis lanceolatis, basi truncatis, glaucis, brevibus vel subtus pubescentibus."—R. et Sch. S. V. ii. 846; Nees, Agros. Bras. 526; Kth. *l. c.* 426; Rupr. *l. c.* 113, tab. i. fig. 3; Harsk. Cat. Hort. Bogor. 19; Steud. *l. c.* 334, et in Zoll. Cat. 56; Miquel, *l. c.* iii. 413. *Ludolfia glaucescens*, Willd. Mag. *l. c.* 320; Spreng. S. V. i. 328; Link. Hort. Berol. i. 248 & ii. 308. *Panicum glaucescens*, Lam. En. Méth. iv. 749. *P. arborescens*, Linn. (fide Nees), sed R. et Sch. *l. suprà c.* recte aiunt, *P. glaucescens* et *arborescens* Lam. et Hort. non Linn.! *Triglossum arundinaceum*, Fisch. et R. et Sch. *l. c.* 846. *Bambusa glauca*, Blume, teste Ruprecht, *l. c.* 160, in Indice, et Rœm. et Sch. S. V. vii. 1355.

Hab. Ind. or.? China? In hortis Europæ et Javæ cult. s. v. Ruprecht.

"*Culmus* suffruticosus, 3–5-pedalis, ramulis dichotomo-fasciculatis. *Folia* in apice ramulorum confertissima sub 8-na, verticaliter disticha, ovato-lanceolata, 1–1½ poll. longa, 3 lin. lata, basi cordato-rotundata, glauca, inferne vel undique, imprimis subtus, albido-glauca, lævia vel brevissime puberula, nervis primariis 2, secundariis 7, margine scaberrima. *Vaginæ* striatæ, glabræ, ore fimbriatæ. *Spiculæ* solitariæ paucæve, nutantes, 2-poll., nitidæ, 6–9-floræ, basi vaginis seu bracteis nonnullis interdum lamigeris tectæ, glumis simillimis, flosculis dissitis, 5–6-linealibus, ovatis acutis, aliis dorso aliis lateribus compressis, articulis rhachillæ 2-lin., glabris. *Palea* superior inferiore subduplo brevior."—*Ruprecht.*

I have never seen a specimen of this plant, but judging from description alone, cannot help believing that the plant is really a species of *Bambusa*, and probably identical with *B. nana*, Roxb., a plant introduced to the Botanic Gardens at Calcutta from China. *Bambusa glauca* of Loddiges and Blume is probably the same; and Rœmer and Schultz, having seen specimens of *B. glauca*, sent to them by Blume himself, but without flowers, state that they cannot distinguish it from *Arundinaria glaucescens*, which they had been acquainted with for many years in gardens, but had never seen in flower. Link says it had only flowered once in cultivation. Lamarck says it had grown in the Paris Gardens for many years, but had never flowered. Ruprecht certainly says he had seen dried flowers, sent to him by Reichenbach, and figures two spiculæ; these are exactly like some spiculæ I have seen of *Bambusa nana*, Roxb., or *glauca* Blume, sent from the Gardens of Java, under the name of *Ischurochloa floribunda*. I am unable to understand Ruprecht's dissection of the spicula in the figure above quoted, as 3 ovaries are represented in one flower, and there is no explanation in the text of the figures. *Panicum arborescens*, Linn. Herb., quoted by Nees as a synonym, is a decided species of *Panicum*, the same as *P. notatum*, Retz.; but attached to the specimens in Linnæus's Herb. is a small piece of

Phyllostachys bambusoides. Fl. Zeyl. 43, also quoted by Nees, is *Panicum ovalifolium*, Poir. Thw. C. P. 889!

12. A. MACROSTACHYA, Nees in Linn. ix. 481. "Foliis lineari-lanceolatis subtus scabris, racemo terminali, spiculis 5–6 retrofractis, 4–5 poll. longis." Rupr. *l. c.* 113 tab. i. fig. 4; Steudel, *l. c.* 334.

Hab. In Brasilia, *Sellow*, s. v. Ruprecht.

"*Rami* graciles, scabriusculi, ad nodos ramoso-subdichotomi. *Folia* lineari-lanceolata, 2 poll. longa, 2½ lin. lata, basi rotundata, subtus scabra, sparse puberula, nervis primariis obsoletis, secundariis 15, interstitiis punctatis. *Vaginæ inferiores* dense pubescentes, ore tenuissime fimbriatæ. *Spiculæ* 5–6 in racemo terminali brevipedicellatæ, alternæ (inferiores quidquam geminæ), retrofractæ, longissimæ, 4–5-poll., coloratæ, nervosæ, sub 9–12-floræ, flosculis dissitis (inferiore quidquam inani et 1-paleaceo, *Nees*) 8 lin. longis articulo rhachillæ 5-lineali glabro insidentibus. *Glumæ* membranaceæ, paleis multo breviores, ovatæ, mucronatæ. *Palea* superior inferiore fere duplo brevior." *Squamulæ* inæquales, apice fimbriatæ. *Ovarium* apice pubescens (teste icone).

13. A. DISTANS, Trin. in Act. Petr. *l. c.* 621 et icon 349. "Culmo scandente, foliis lineari-lanceolatis subtus glaucescentibus, spiculis 3–4 brevipedicellatis vel sessilibus in spicam terminalem dispositis, glumis fere obsoletis."—Rupr. *l. c.* 114, tab. ii. fig. 6; Steud. *l. c.* 335.

Hab. Brasiliam: in umbrosis montis Itacolumi, *Riedel*, s. v. Trinius et Ruprecht.

"*Culmus* altissimus scandens, basi diametro ½ poll., ramis filiformibus, internodiis plus minus palmaribus; ramulis 3–5, rarius solitariis, palmaribus—spithamæis, apice floriferis e nodis glabris erumpentibus, divaricatis vel recurvis. *Folia* e basi ovata lineari-lanceolata, 1–2½ poll. longa, 2–3 lin. lata, mucronulato-acutata, brevipetiolata, glabra, subtus glaucescentia et interdum scabriuscula, latere dimidio nitida, margine scaberrima, costa inferne tantum conspicua, nervis primariis obsoletis, secundariis in tota lamina 24–30. *Vaginæ* striatæ glabræ, margine ciliolatæ, ore fimbriatæ ciliis pluribus 1–2, linealibus, ligula brevissima. *Spiculæ* 3–4, sessiles vel brevipedicellatæ, in spicam terminalem dispositæ, 8–12 lin. longæ, coloratæ, 2–4-floræ, rhachilla glabra. *Glumæ* 2, pusillæ, vix nisi lentis ope conspicuæ, a flosculis remotæ, oblongæ acutiusculæ, enerves, inferior paulo brevior et angustior. *Paleæ* sæpe patentes, inferior acutissima, glabra, 7-nervis, superior paulo brevior (multo minor fide Ruprecht), apice obtuso bifida. *Squamulæ* 3, acutiusculæ, obsolete nervatæ, dense fimbriatæ. *Stamina* 3. *Stylus* cito bifidus. *Ovarium* lineari-oblongum, apice attenuatum. Rudimentum terminale nullum (fide Trin.)."

I have not seen any specimen of this; but from Trinius's drawing and the description, it evidently approaches very closely to *Arthrostylidium*.

14. A. VERTICILLATA, Nees in Agros. Bras. 523. Ramulis semiverticillatis, numerosis, nunc foliosis apice floriferis nunc aphyllis floriferis tantum, spiculis sæpe 2 poll. et ultra longis, in racemis 2–5, lineari-lanceolatis, 5–9-floris, foliis lanceolatis utrinque scabris.—Kunth, Rev. Gram. ii. 483, tab. 155, 156; Enum. i. 427: Rupr. *l. c.* 115, tab. 3. fig. 7: Trin. in Act. Petrop. *l. c.* 623: Steud. *l. c.* 335. *Ludolfia verticillata*, Dietr. Spec. ii. 25.

Hab. Brasiliam, *Sellow*!; Goyaz, *Burchell*, no. 6412! (specimina pulcherrima!), v. s.

Culmus 10–15-pedalis, inanis, fistulosus, lævigatus, nitidus, inferne diametro 2 lin., internodiis 6–11-poll. glaberrimis, apice sæpius laxe pendulus. *Ramuli* $\frac{1}{3}$–1 ped. et ultra longi, numerosi, usque ad 40, ad nodos glabros semiverticillati, superiores foliosi, apice floriferi, inferiores sæpe aphylli. *Folia* lineari-lanceolata, basi inæquilatera, rotundata vel subattenuata in petiolum brevem lutescentem, plerumque 3–4 poll. longa, 4–6 lin. lata, interdum, perpauca (ad apicem culmi), 7–8 poll. longa et 9 lin. lata, utrinque et margine scabra, subtus pallidiora, nervis secundariis 4–6 fere obsoletis, tertiariis 3–5. *Vaginæ* fere glabræ, superne nervosæ, ore ciliis fragilibus (apicibus cito caducis) fimbriatæ. *Panicula* terminalis depauperata, racemosa, sub 3-pollicaris, laxa, erecta vel nutans, spiculis 2–5 plerumque 3, rhachi pedicellisque (spiculis brevioribus) pubescenti-scabris. *Spiculæ* intra glumas longe stipitatæ, lineari-lanceolatæ, $1\frac{1}{4}$–$2\frac{1}{2}$ poll. longæ, pallide stramineæ, glabræ, 5–9-floræ, flosculis 1–3 terminalibus tabescentibus, rhachillæ articulis pubescentibus apice sericeo-barbatis. *Glumæ* inæquales, acuminatæ, flosculo inferiore 3–4-plo breviores, multinervosæ. *Palea* inferior herbacea, 6–8 lin. longa, lanceolata, subulato-acuminata, sub 13-nervis, nervis alternis tenuioribus et abbreviatis, colore glumarum; superior brevior vel fere æquilonga, apice obtusa, 8–10-nervis, carinis, præcipue basin versus, ciliatis. *Squamulæ* 3 inæquales (1 multo minor), lato-oblongæ, obtusæ, margine minute fimbriatæ, basi colorato-nervosæ et callosæ. *Stamina* 3, filamentis basi callosis, antheris longis demum exsertis. *Stylus* basi subbulbosus, et hirsutus, attenuatus et non longe supra basin in stigmata 2 (fide Nees 3) pulchre plumosa divisus. *Fructus* maturus 5-linearis, oblongus, (pericarpio inclusus, fide Kunth) an morbosus?, glaber, apice residua styli basi coronata.

This is the most beautiful of the whole genus; and the apparent structure of the fruit is quite unique. Burchell's fine specimens contain many fruits nearly ripe; and there is certainly an appearance of a pericarp, which, unless it is due to disease, I am unable to explain. The structure, however, is quite different from that of berry-bearing Bamboos. There is no beak enclosing the base of the style, which is decidedly articulate at the apex of the fruit. The scutellum and longitudinal sulcus are outwardly perceptible after long maceration. In very young specimens the base of the style is as conspicuously swollen as it is in *Bambusa tulda*. Burchell says it is called "Taquára mirim," and grows near rivulets in woods.

15. A. DEBILIS, Thwaites in Enum. Pl. Zeyl. 375. Foliis parvis, glabris, vel superne pilosis, nervis transversalibus, interdum, sed raro, quam minime conspicuis, panicula simplici, pedicellis plerumque brevissimis, axillis glandulosis, spiculis subglabris 3-floris, glumis longis.

Hab. Ceylon, Prov. Centr. 6000–8000 p. s. m., *Thwaites*, C. P. N. 1!; *Dr. Maxwell*!; *Wight*, no. 1348! *Thomson*! v. s.

Culmi valde elongati (2–5 lin. in diam. Thw.), internodiis 2–6 poll. longis, apice glabris vel pilis longis hispidis. *Folia* parva, $1\frac{1}{2}$–3 poll. longa, sub 3 lin. lata, lineari-lanceolata, pallida, margine uno vel utroque ciliata, apice acutissima, glabra vel superne pilosa (pilis longis), basi acutata vel subtruncata, nervis secundariis utrinque 2 sæpe inconspicuis, venulis transversalibus distantibus, quam minime conspicuis, sæpe obsoletis. *Vaginæ* glabræ vel plus minus hispidæ, ore ciliis 2–4 fimbriatæ, ligula brevi. *Paniculæ* subsimplices ramos paucifloros semiverticillatos terminantes, rhachi angulata, pedicellis plerumque brevissimis sæpe obcuneatis, axillis glandulosis. *Spiculæ* 3-floræ, sub 6 lin. longæ, rhachillæ articulis scabris, fere glabræ. *Glumæ* subacutæ, mucronatæ, 6–7-nerviæ, pilosulæ, inferior parum brevior, pallidæ vel coloratæ, superior paleam inferiorem subæquans. *Palea* inferior 7-nervis, mucronata, apice hirsutiuscula, superior apice acuminata, carinis fere glabris, longior. *Squamulæ* inæquales, angustæ, colorato-nervosæ. *Stylus* cito bifidus in stigmata 2 subpurpurea.

The foliage of this plant is used at Newera Ellia as a fodder for horses (*Thw.*). The length of the glumes at once distinguishes this from *A. distans*, which in some respects it approaches.

16. A. ACUMINATA, Munro. Foliis linearibus *angustissimis* glaucis, paniculæ subsimplicis ramis pedicellisque sæpissime gracilibus, spiculis sub 4-floris, pubescentibus, glumis *longissime setaceo-acuminatis*.

Hab. Mexico, Dep. Vera Cruz! *Leibmann*, no. 73! v. s.

"*Culmus* 12–20-pedalis, basi digito parum crassior" (*Lieb.*), vix fistulosus, internodiis (superioribus) 2–3 poll. longis, glabris vel superne pruinoso-glaucis, ramulis 3–5 poll. longis, ad nodos sub 3, fere omnibus proliferis, ultimis floriferis. *Folia* angustissima, 2–3½ poll. longa, vix lineam lata, glauca, basi vix attenuata, apice acutissima, margine serrulata, non raro subtus basin versus pilis longis hirsuta, cæterum glabra, nervis secundariis utrinque 1–2. *Vaginæ* profunde striatæ, subglabræ, ore ciliis brevissimis inconspicuis fimbriatæ, ligula brevi. *Panicula* subsimplex, ramis paucis tenuibus angulatis scabro-hirsutiusculis, pedicellis inæqualibus brevibus vel longis, axillis eglandulosis. *Spiculæ* 3–4-floræ, 8–10 lin. longæ, pubescentes, rhachillæ articulis apice sericeo-barbatis. *Glumæ* inæquales, nervosæ, *longissime setaceo-acuminatæ*, apice fimbriatæ; inferior 3-nervis; superior sub 5-nervis, 4½ lin. longa (acumine bilineali scabro incluso). *Palea* inferior semipollicaris, longe acuminata, 7-nervis, dorso hirsuto-pubescens, (dempto acumine) superiorem fere enervosam obtusam inter carinas apice tantum hirsutam vix superans. *Squamulæ* subæquales, obovatæ, obtusæ, longe fimbriatæ. *Stylus* cito bifidus in stigmata 2 longa basi nuda apice pennata. *Ovarium* infra stylum constrictum.

I have seen only the upper portions of the stem of this plant. In the style of the inflorescence it approaches *A. debilis*, Thw.; but from this and all other species of the genus it is readily distinguished by its extremely narrow leaves and very long points to the glumes. In this latter respect it resembles several species of *Chusquea*.

17. A. TRIANÆ, Munro. Foliis lanceolatis subtus glaucis, venulis transversis nullis, vaginis sæpissime superne viscosis ore longe fimbriatis, paniculæ terminalis compositæ ramis sublongis demum refractis, spiculis *heterogeneis* 6–12-floris, glumis valde inæqualibus, inferiore minima.

Hab. N. Grenada, Andes de Bogota! Alt. 2800 p. s. m., *Triana*! v. s.

Culmi (pars superior tantum adest) internodiis 2–3 poll. longis glabris, ad nodos ramulos 1–2 sesquipedales gerentibus. *Folia* lanceolata, 4–5 poll. longa, 5–9 lin. lata, apice longe acuminata, basi inæquilatera, angustata in petiolum sublongum flavescentem, tactu aspera, margine asperrima, subtus glauca, nervo centrali supra medium ægre discernendo, secundariis uno latere 2–3, altero 3–4. *Vaginæ* striatæ, sæpe (præsertim superiores) superne *viscidæ*, ore ciliis longis multis fimbriatæ, ligula vix ulla. *Panicula* bis terve composita, 4–5 poll. longa, *ramis inferioribus* 3 poll. longis, tandem *refractis*, rhachi glabra, pedicellis plerumque spicula brevioribus. *Spiculæ heterogeneæ* plurimæ, 4–6-floræ, flosculis omnibus bipaleaceis, sed sæpe masculis tantum, paucæ 8–12-floræ, flosculis omnibus, nisi supremis 2–3, tabescentibus, hermaphroditis, vel raro infimo masculo bipaleaceo, glabræ vel subviscosæ, articulis rhachillæ brevibus fere glabris. *Glumæ* inæquales, basi lutescentes, inferior minima 1-nervis, superior sub 5-nervis, 3 lin. longa, carinata. *Palea* inferior nervosa sub 7-nervis, mucrone brevissimo acuminata vel subobtusa, glabra nisi utrinque ad basin ubi pilis sublongis hirsuta; superior in flosculis masculis brevissima, in perfectis inferiorem æquans, bicarinata, carinis superne

tantum serratis. *Squamulæ* 3 æquales ovatæ obtusæ, apice fimbriatæ, hyalinæ. *Stamina* 3 filamentis brevibus. *Stylus* cito bifidus in stigmata 2 brevi-plumosa. *Ovarium* (immaturum) in stylum attenuatum.

In many respects, especially the heterogeneous spiculæ and the vanishing of the midrib of the leaves above the middle, this species approaches *Arthrostylidium maculatum*, Rupt., affording another indication of the proximity of the two genera. However, the very long cilia to the vaginæ and short ligulæ at once distinguish this from Ruprecht's plant. M. Triana's specimens contain very few perfect spiculæ.

18. A. AMPLISSIMA, Nees in Linnæa, ix. 479. Foliis ovato-lanceolatis 2–3 poll. latis, venulis transversis nullis, panicula decomposita amplissima, spiculis 3–5-floris.—Rupr., *l. c.* 116, tab. i. fig. 11; Steud. *l. c.* 335.

Hab. in Brasilia, *Sellow*!; Organ Mnts., alt. 4000–5000 p. s. m., *Gardner*, 709! & 5911! v. s.

Culmus altus (*Rupr.*) 6-pedalis (*Gardner*) fistulosus, crassitie pennæ cygneæ, an ramosus? *Folia* ovato-lanceolata, crassa, 2–3 poll. lata, 6–8 poll. longa (ramulorum sterilium 2 poll. lata, 3 poll. longa, fide Rupr.), apice attenuata, basi rotundata, breviter petiolata, scabra, subtus glauca, densissime elevato-punctata, asperula, nervis secundariis utrinque 9–11, tertiariis 7–8, venulis transversis nullis. *Vaginæ* sulcato-striatæ, sæpe punctatæ, glabræ, ore ciliis longis rigidis flexuosis scabris fimbriatæ. *Panicula* terminalis decomposita, *sesquipedalis*, 9-11 poll. lata, amplissima, effusa, ramis *patentibus* vel divaricatis, rhachi glabra, axillis bulbosis, pedicellis longis. *Spiculæ* lanceolatæ, 5–6 lin. longæ, compressiusculæ, chartaceæ, fusco-griseæ vel pallidæ, 3–5-floræ, flosculis acutiusculis nervosis glabris vel sub lente hirsutiusculis, rhachillæ articulis glabris. *Glumæ* lanceolatæ acutæ, inæquales; inferior duplo minor, 1-nervis; superior sub 5-nervis, spicula duplo brevior. *Paleæ* subæquales, fere glabræ, inferior vix acuta, nervis 5–7 inconspicuis; superior obtusa, bicarinata. *Squamulæ* subæquales, lanceolatæ, acutiusculæ vel obtusæ, membranaceæ, longe fimbriatæ, dorso pubescentes. *Stylus* cito bifidus in stigmata 2 (3, fide Rupr.) basi nuda apice brevi-plumosa. *Ovarium* oblongum in stylum subito attenuatum.

The specimens which I have seen of this species contain each a panicle with 1 or 2 leaves, and therefore give no information as to the habit of the plant. Gardner says that it grows 6 feet high, and is found in the virgin forest and in moist rocky places. Ruprecht describes and figures the style as trifid, and the squamulæ quite smooth; but in the specimens which I have examined, including one from Sellow, the style is decidedly bifid, and the squamulæ are much fringed.

Section II. *Culmi foliiferi et floriferi distincti, quotannis florigerentes, hieme necati, vere e surculis progerminant.*

19. A. FALCATA, Nees in Linnæa ix. 478. Culmo florente aphyllo, ramulis simplicibus vel compositis, semper gracilibus, ad nodos semiverticillatis, racemulis ultimis falcatis, spiculis 2–4-floris plus minus longe pedicellatis, glumis nervosis superiore flosculum infimum subæquante, foliis angustis subtus circa costam pilosis, venulis transversis nullis.—Rupr. *l. c.* 115, tab. iii. fig. 8; Steud. *l. c.* 335; *A. interrupta*, Trin. in Act. Petr. *l. c.* 620; *A. utilis*, Cleghorn, in Journ. Agr. Soc. of India, xiii. 388 (1865); *Ludolfia falcata*, Nees. Quoad inflorescentiam variat α. ramulis floriferis fere simplicibus falcatis, β. ramulis floriferis proliferis compositis interdum valde elongatis.

Hab. in Himalaya et Nepalia: var. *a*. Nepal! *Wallich*; Mussoorie! *Falconer*! *Royle*, no. 315!; Nynee Tal., alt. 5000–7500 p. s. m., *Strachey* 477!; Dalhousie, in Chumba, Him., *Pinwell* 279! Var. *β*. Nepal, Cheesapong! *Wallich, Cat.* 5035!; Mussoorie, *Falconer*!; Kedarkanta, *Falconer*!, *Munro*! In summa valle Jumnæ, *Jacquemont* 790! N.W. India!, *Royle in Herb. Hook.*! Folia tantum, Landour! *Thomson*; Nynee Tal, *Thomson*, 1020! in montibus Khasia; Nurtiung, *Hooker*!; Sariong (var. ramulis foliiferis pendulis), *Thomson*! Kew et Cork cult., vide *supra*, p. 10. "Nigala" incolis, fide *Royle* et *Cleghorn*; "Prong," fide *Thomson*. V. v. et s.

Culmus 6–10-pedalis (in cult. 16–20, teste Moore, *l. c.*), quotannis e surculis oriens, basi 2–3 lin. diametro, spathis striatis glabris subsemipedalibus apiculo unciali, internodio infimo brevissimo 3–5 lin. longo tomentoso-barbulato, 2–3 sequentibus 1–2 poll., supremis 4–5 poll. longis, nodis (in eodem culmo) hirsutis vel glabris; in florente culmo ramulis numerosis filiformibus basi brevi-bracteatis, primum simplicibus 2–3 poll., deinde proliferis compositis sæpe sesquipedalibus; in foliifero ramulis filiformibus plerumque proliferis, ad nodos semiverticillatis. *Folia* angusta, 2–3 vel raro 4–6 lin. lata, 3–4–6 poll. longa, apice setaceo-acuminata, basi in petiolum attenuata, glaucescenti-viridia, glabra, *nisi subtus circa costam* ubi *pilosa* sunt, nervis secundariis utrinque 3–4, venulis transversis nullis. *Vaginæ* striatæ, inferiores usque ad basin solutæ, superne purpurascentes vel pallidæ, pilis longis sæpe hirsutæ, apice ciliis perpaucis cito deciduis, raro fimbriatæ, ligula elongata. *Panicula* falcata, (in var. *a*) basi bracteata, longe pedunculata, spiculis 4–7 plus minus longe pedicellatis, simpliciter racemosa, axillis sæpe pilosis; in var. *β* racemis brevioribus, spiculis 3–4 (nisi terminali), brevi-pedicellatis. *Spiculæ* intra glumas sessiles, 6–8 lin. longæ, 2–4-floræ, plerumque flosculis 2 perfectis cum rudimento tertii, articulis rhachillæ obcuneatis sub lente tantum pubescentibus, flosculis fere dimidio brevioribus. *Glumæ* membranaceæ, inæquales, nervosæ, apice ciliatæ; inferior minor, 1–3–5-nervis, acuminata, sæpe toto margine fimbriata; superior 7–9-nervis, vix acuta, flosculum infimum fere æquans. *Paleæ* sub lente scaberulæ; inferior nervosa, 7–9-nervis, acutiuscula, membranacea, apice hirsuta; superior subæqualis vel raro longior, apice vel acuto vel bifido, bicarinata, et utrinque præterea binervis. *Squamulæ* 3, æquales, obtusæ, ovatæ, fimbriatæ et nervosæ. *Stamina* 3, antheris demum exsertis, filamentis sæpe explanatis. *Stylus* in stigmata 2 a basi longe plumosa cito bifidus. *Ovarium* lineari-oblongum in stylum attenuatum.

This is an extremely variable plant; and it is only after the examination of numerous specimens, collected at different periods of the year and in all stages of intermediate variation, that I feel persuaded I am right in placing them all in one species. When first the plant appears in the spring, the branches of the flowering stem are nearly simple, bearing at the nodes longish racemes, with a few short bracteæ at their base, the whole inflorescence not exceeding 5 or 6 inches in breadth. As the season advances, many of these simple branches become proliferous, and are often 1 foot and a half in length, bearing at all their nodes 3 or 4 racemes much shorter than those first produced. At last the inflorescence becomes very much branched, and presents an appearance totally unlike that seen in the young shoots; and this compound form is the state represented by Wallich's No. 5035! collected in December 1820. Trinius described his *A. interrupta* from specimens preserved in the British Museum, collected by Wallich in the earlier part of the previous year; but, shortly before Trinius's paper appeared, Nees described the plant, from some of Royle's specimens, as *A. falcata*. Speaking of this plant, Royle, in his 'Illustrations of the Botany of the Himalayas,' says, "One of the Bamboo tribe, which in the hills is used for the same purposes as the bamboos in the plains, is found commonly at elevations from 7500 to 10,000 feet; its annual stems are yearly beaten down by the

falls of snow, which protect its perennial roots from excessive frost. This does not, however, belong to the genus *Bambusa*, but is nearly allied to *Chusquea* of Humboldt, found in the cold mountains of Quito and Santa Fe de Bogota." This plant has an extensive range in the Himalayas, as will be seen from the various localities quoted above. Falconer's herbarium contains numerous specimens of it in various stages of growth; and it may therefore be the plant he intended as "Thamnocalamus," and not the one which I have described as a genus under that name. This species approaches very closely to *A. Khasiana*, which is best distinguished from it by having leaves quite smooth below, and by the violet colour of the stem and branches, whilst in *A. falcata* the whole plant has a pale yellowish hue, except in the young spiculæ and vaginæ, which are occasionally purplish.

20. A. KHASIANA, Munro. Culmo florente aphyllo; ramulis plerumque compositis, longis, sæpe 1½–2-pedalibus, validis; spiculis, nisi terminali, brevi-pedicellatis, 2–3-floris, glumis nervosis flosculo inferiore multo brevioribus; foliis angustis, subtus glaberrimis.

Hab. Khasia, Chillong, alt. 5800 p. s. m., *Griffith*, no. 1058!; Churra! Syong, no. 1466!; alt. 5700 ped., *Hooker*!; Assam 1089! *Masters*. "Namlang" incolis, fide Hooker, v. s.

"*Culmus* inermis, gracilis, 8–12-pedalis" *Griff.*), internodiis valde variabilibus, 2–6 poll. longis, in florente juvenili approximatissimis, ramulis foliiferis violascentibus. *Folia* subtus glaberrima viridia, ceteroquin ut in *A. falcata*. *Vaginæ* pallidæ, plerumque glaberrimæ, apice efimbriatæ, ligula sæpe elongata obtusa. *Panicula* falcata, ramosa, semper brevis, 1½–3 poll. longa, basi bracteata, multæ circa nodos culmi vel ramulorum proliferorum dense aggregatæ, spiculis 5–7, pedicellis omnibus, nisi terminali, brevibus, crassis, infimis 1–2 fere obsoletis (spiculæ subsessiles). *Spiculæ* 2–3-floræ, sæpe nigrescentes, articulis brevibus albo hirsutis. *Glumæ* inæquales, apice fimbriatæ; inferior minor, membranacea; superior 5–7–9-nervis, apice brevissime mucronata, dimidium flosculi infimi nunquam attingens. *Palea* inferior nervosa, nervis 7–9 validis, apice brevissime mucronata, margine ciliata et lateribus interdum pubescens; superior fere semper multo longior, carinata, dorso subscabra. *Squamulæ* basi coloratæ, nervosæ, apice longe fimbriatæ, obtusæ vel subacutæ. *Stylus* in stigmata 2 vix longe plumosa cito bifidus, interdum crure uno iterum divisus. *Ovarium* lineari-oblongum, basi attenuatum.

As already stated above, this species is very closely allied to *A. falcata*; but it has always a different look. The leaves are invariably glabrous below; the glumes are also much shorter than in *A. falcata*, as also are the spiculæ and pedicels. The branches of the panicle are much denser and more imbricated; and the plant appears to be of stronger growth generally. The specimens which I have seen were collected in August and October; and therefore, having never seen young states of the plant, I do not know whether the branches are ever simple, as they are in the early growths of *A. falcata*.

21. A. INTERMEDIA, Munro. Culmo florente aphyllo?, ramulis inferioribus compositis basi longe nudis, superioribus fere sessilibus, paniculis sæpe compositis, longis, plerumque erectis, spiculis 3–5-floris, glabris, foliis lanceolato-linearibus, supra scabris, 6–12 lin. latis, venulis transversis subtus plus minus conspicuis, petiolo supra hirsuto.

Hab. Sikkim! alt. 7000–8000 ped. s. m., *Hooker*, v. s.

Culmus 6–8-pedalis?, eximie fistulosus, pallidus, internodiis sæpe semipedalibus, nodis hirsutis vel subglabris, ramulis foliiferis floriferisque, inferioribus 1–3-pedalibus, 2–4-nodosis, floriferis supremis

sæpe brevibus, 2–5 poll. longis. *Folia* lineari-lanceolata, 6–12 lin. lata, 4–6 poll. longa, subtus pallida et sæpe basin versus ad costam pilosa, supra vel utrinque scabra, apice acuta, basi attenuata in petiolum, vel supra tantum vel supra subtusque scabro-hirsutum, nervis secundariis utroque latere 3-5–7 venulis transversis subtus plus minus conspicuis, distantibus. *Vaginæ* sulcatæ, glabræ, apice sæpe biauriculatæ et ciliis plus minus longis fimbriatæ, ciliis caducis demum quasi efimbriatæ, infra petiolum membrana ciliata terminatæ, ligula conspicue elongata obtusa. *Paniculæ* plerumque compositæ, rarissime apicem culmi versus simpliciter racemosæ, sæpe 5-pollicares, ad nodos culmi vel ramulorum dense semiverticillatæ, basi bracteis hyalinis membranaceis bracteatæ, sæpissime erectæ, adpressæ et plerumque internodia superantes, axillis barbatis, pedicellis spiculis brevioribus. *Spiculæ* 7–12 lin. longæ, basi flavæ, apice coloratæ, 3–5-floræ, rhachillæ articulis longis hirsutis apice fimbriatis. *Glumæ* nervosæ, pallidæ, membranaceæ, vix acutæ, apice ciliatæ; inferior 7-nervis (an semper?); superior longior, basi 7–9-nervis, apice hirsuta. *Palea* inferior nervis 7–9 conspicuis notata, glumam superiorem duplo superans, apice vix acuta et hirsutiuscula; superior sæpe longior, bimucronata, apice tenui-ciliata, inter carinas binervosa. *Squamulæ* 3, basi subcallosæ, perspicue colorato-venosæ, apice ciliatæ. *Stylus* cito bifidus. *Ovarium* lineari-oblongum, medio subtumescens, apice coloratum.

In foliage this approaches *A. Hookeriana*, and in the structure of the spiculæ *A. falcata* and *A. Khasiana*; it is, however, quite distinct from all three, and when in flower is readily distinguished by its generally adpressed and often compound racemes. Dr. Hooker appears to have only once collected the plant in flower, and the specimens I have seen are consequently all from one flowering and one leaf-bearing culm.

22. A. Hookeriana, Munro. Culmo florente aphyllo, ramulis superioribus subsimplicibus, inferioribus proliferis, spiculis fere semper sesquifloris, perspicue 3–5-carinatis, interstitiis hirsutis, foliis lineari-lanceolatis, sub 6 lin. latis, venulis transversis subtus vix conspicuis.

Hab. Sikkim, alt. 4000–6800 ped. s. m., Yoksun!, "Praong" incolis, *Hooker*, v. s.

Culmus 12–15-pedalis, gracilis, fistulosus, diametro interdum 5–6 lin., internodiis 2–6 poll. et ultra longis, ramulis floriferis basi bracteatis, supremis (culmi) brevibus 2–3 poll., inferioribus proliferis pedalibus et ultra, nodis hirsutis vel raro subglabris. *Folia* (dubia) lineari-lanceolata, 4–6–10 lin. lata, 5–6 poll. longa, glaucescentia, utrinque glabra, vel raro subtus basin versus hirsuta, apice acuminata, basi subito attenuata in petiolum brevem, nervis secundariis 3–4 cum venulis transversis subtus inconspicuis. *Vaginæ* striatæ, glabræ, apice efimbriatæ, ligula elongata conspicua sæpe colorata. *Panicula* basi bracteata, simplex, subfalcata, spiculis 6–10, pedicellis plerumque longis, multæ ad nodos culmi vel ramulorum dense fasciculatæ. *Spicula* typice *sesquiflora*, rarissime flosculis duobus perfectis, sub 4 lin. longa, intra glumas sessilis callo hirsuto, dorso perspicue 1–5-carinata. *Glumæ* pallidæ, membranaceæ, inconspicue nervosæ, inferior 3–5, superior 5–7-nervis, nervo centrali interdum subconspicuo. *Palea* inferior involvens, crassa, nervo centrali et 2–4 lateralibus demum nitidis, 3–5-costata, interstitiis hirsutis; superior æquilonga, apice hirsuta, profunde sulcata. *Squamulæ* æquales, oblongæ, magnæ, basi callosæ et colorato-venosæ, apice longe ciliatæ. *Ovarium* breve, in stylum cito bifidum attenuatum. "*Fructus* longus, coloratus, oryzæ similis, edulis," *Hooker*.

In many respects this approaches *A. falcata*; but the peculiar angled or ribbed spiculæ distinguish it from all other species. These angles often become much polished, whilst the spaces between are hirsute. Unfortunately there are no leaves attached to the flowering specimens; and my only authority for the foliage are some leaves collected at "Yoksun" in Sikkim, and marked "Praong" by Dr. Hooker. In the 'Himalayan

Journals,' Dr. Hooker states that he found a plant of "Praong" at the top of the pass above "Neongong," at an elevation of 6800 feet, in full seed; and adds, "The 'Praong' sends up many flowering branches, and but few leaf-bearing ones from the roots; and after maturing its seed, and giving off suckers from the root, the parent plant dies. The fruit is boiled, and made into cakes or into beer."

ARUNDINARIÆ *cognitæ steriles* (*foliiferæ tantum*), *igiturque, quoad genus, dubiæ.*

* Folia supra subtusque perspicue tessellata, venulis transversis creberrimis, interstitiis in *A. callosa* et *A. Hindsii* oblongis, in reliquis fere quadratis.

23. A. CALLOSA, Munro. Foliis lineari-lanceolatis, 8–12–17 lin. latis, 8–9 poll. longis, margine membranaceo, venulis transversis subdistantibus, *petiolo* basi *calloso*.

Hab. Himalaya in montibus Khasia, Moflong! alt. 6000 ped. s. m. ("prickly-jointed Bamboo"); Myrung, alt. 5650 ped., no. 1504! "Uskong" incolis, *Hooker*, v. s.

Culmus "12-pedalis," internodiis apices versus interdum "spinoso barbatis" (*Hooker*), plerumque tandem flavo-hirsutis, nodis prominulis glaberrimis. *Folia* lineari-lanceolata apice longe acuminata, basi subcuneata et attenuata in petiolum flavescentem ima basi *callosum*, subtus pilosa vel glabra, subconcoloria, nervis secundariis utrinque 6 conspicuis, venulis transversis crebris elevatis, interstitiis oblongis. *Vaginæ* apices versus dense fusco hirsutæ, inferne subglabræ, membrana brevissima ciliata terminatæ, non auriculatæ sed utrinque ciliis sublongis fimbriatæ, ligula brevi.

The long leaves, with the secondary nerves very strongly marked, distinguish this at once from all the species of *Arundinaria*, of which the leaves only are known. In Herb. Hooker. this is marked as "prickly-jointed Bamboo," and it is added that "some of the bearded nodes are preserved in bottles in the Kew Museum." I have already, at p. 21, referred to these curious nodes; but it is possible that they may belong to this species instead of to *A. Griffithiana* as I suppose, although I cannot, in any of the dried specimens, discover traces of any spinous processes, whereas in *A. Griffithiana* they are often to be found.

24. A. HIRSUTA, Munro. Foliis lanceolatis, 4–10 vel raro 14 lin. latis, 2–6 poll. longis, margine cartilagineo, subtus pallidis hirsutis vel demum glabrescentibus, vaginis plerumque hirsutis, apice auriculis reversis biappendiculatis.

Hab. Himalaya, in montibus Khasia, Myrung! alt. 5600 p. s. m. "apud saxa," *Griffith*; Syong! 5700 p., Moflong! 6000 p. "in sylvis, humilis culmis spinosis," *Hooker*, v. s.

Culmus 2–4-pedalis, "fastigiatus ramosus spinosus" (*Hooker*), internodiis sub 2 poll. longis, sæpissime (et præcipue apices versus) strigoso-hirsutis, nodis ipsis glabris. *Folia* lanceolata, plerumque 2–4 poll. longa et 4–7 lin. lata (interdum majora sunt usque ad 14 lin. lata et 6 poll. longa), acutissima, basi attenuata in petiolum brevem et latum, margine cartilagineo longe fimbriato, subtus pallida et sæpe pilis longis hirsuta, nervis secundariis utrinque 4–6, venulis transversis creberrimis, interstitiis quadratis. *Vaginæ* sulcatæ, superne pilis longis hirsutæ vel hirsutissimæ, raro demum glabrescentes,

apice membrana *pilis interdum rigidis vel etiam spinescentibus ciliata* terminatæ lateribusque auriculis duabus reversis conspicuis et ciliis subrigidis longe fimbriatis appendiculatæ, ligula elongata sæpe nigrescente.

In the dried state many of the leaves of this species assume a reddish hue on the upper surface. The specimens from Moflong are marked by Hooker as having "spinous stems." The cilia terminating the membrane below the petiole, as well as those fringing the auricles, occasionally become much elongated and stiffened; but these could scarcely be called spinous, and in the numerous dried specimens I have had access to I can find nothing approaching to spines or likely to become so under any circumstances.

25. A. TESSELLATA, Munro. Foliis lineari-lanceolatis, 5–9 lin. latis, 2–5 poll. longis, margine membranaceo setuloso-ciliato, utrinque pallidis et glabris, vaginis dorso glabris, apice ciliis pallidis fimbriatis, ligula elongata fimbriata.—*Nastus tessellatus*, Nees, Fl. Afr. Aust. 463; Steud. Syn. 333.

Hab. in Africa austr. *Zeyher*! "In monte Winterberg (terræ Caffrorum) alt. 5000–6500 p. s. m., *Ecklon*; "in monte Katberg, alt. 500 p.," *Drège*! v. s.

"*Arborescens*, in humidis 15–20-, in siccioribus 5–10-pedalis," culmo fistuloso, "internodiis 1½ poll. longis." *Folia* lineari-lanceolata, glabra, acuminata, basi rotundata vel attenuata in petiolum brevem subhirsutum, nervis secundariis utrinque 3 subinconspicuis, venulis transversis creberrimis, areolis depressis subquadratis. *Vaginæ* pallidæ, striatæ, margine superius et circa os ciliatæ, ligula plerumque elongata (brevi, fide Nees) truncata et ciliata.

This plant appears to be widely dispersed in the extreme south of Africa; and a whole range or district is called "Bambusbergen," apparently after it. It has also a remarkable and unusual range of elevation, from 500 to 6500 feet above the sea. Unfortunately, however, Drège's remark still holds good, "nunquam cum flore aut fructu a nobis inventa est." I have therefore no authority for placing the plant in *Arundinaria* except the very great resemblance it bears in habit and general appearance to that genus, and especially to *A. macrosperma*, from which it is principally distinguished by its glabrous leaves and elongated ligule. Nees, to a certain extent, confirms my opinion when, in describing this plant, he says, "Monendum tamen *Chusqueæ* habitum præ se ferre hoc gramen."

26. A. HINDSII, Munro. Foliis angusti-lineari-lanceolatis, 4–5 lin. latis, 3–6 poll. longis, *coloratis*, margine subcartilagineo vel lævi vel brevissime serrulato, vaginis demum glabris, utrinque ciliis paucis, 4–5, fimbriatis.

Hab. Hongkong! *Hinds* (1841) *in Herb. Bentham*, v. s.

Culmus (pars superior, 1½-pedalis, tantum adest) fistulosus, ramosus, internodiis 2–3 poll. longis, glaberrimis, ramulis 2–3, subsemipedalibus, ad nodos subprominulos fasciculatis. *Folia* angusta, setaceo-acuminata, basi attenuata in petiolum glabrum *striatum*, utrinque glabra, subconcoloria, nervis secundariis utrinque 3, venulis transversis crebris elevatis, interstitiis oblique oblongis. *Vaginæ* striatæ, *coloratæ*, marginibus tenuissime ciliatis vel glabris, apice ciliis paucis sublongis fimbriatæ, ligula inconspicua dorso hirsuta.

I have seen only one specimen of this, collected by Hinds; and it seems curious that so conspicuous a plant should not have attracted the attention of other collectors. The very narrow, dark-coloured, conspicuously tessellated leaves at once distinguish it from *A. longiramea*, the only other species of *Arundinaria* which I have seen from Hongkong. It does not closely resemble any *Arundinaria* I am acquainted with.

27. A. DENSIFOLIA, Munro. Foliis sessilibus, lanceolatis, spinoso-acuminatis, densis, brevibus, 1–4 lin. latis, $\frac{1}{2}$–$1\frac{1}{2}$ poll. longis, margine cartilagineo pulchre fimbriato, utrinque glabris, vaginis striatis, interstitiis hirsutis, apice efimbriatis.

Hab. Ceylon, *Watson*, no. 25! *Dr. Maxwell*!; Pedrotalagalla (in paludosis), *Thomson*! v. s.

Culmus $\frac{1}{2}$–3-pedalis, internodiis numerosis subsesquipollicaribus, spathis coloratis dorso hirsutis superatus, ramulis virgatis, 5–8, brevibus, ad nodos glabros, fastigiatis. *Folia* dense imbricata, interdum brevissima, 5 lin. longa, maxima $1\frac{1}{2}$ poll. longa, acumine pungente scabro terminata, crassa, nervis secundariis inconspicuis, venulis transversis sat crebris, interstitiis impressis subquadratis, interdum, nisi folia madida sint, hæ venulæ occultæ sunt. *Vaginæ* breves, striatæ, interstitiis pilis sublongis hirsutæ, apice efimbriatæ vel brevissime ciliatæ, ligula inconspicua.

This may possibly be a peculiar state of *A. Walkeriana*, as I have already suggested in describing that species at p. 22. I think, however, that the absence of cilia (which are generally more conspicuous in young than in old states of Bamboo), the extremely small leaves with such very long points, the absence of any distinct secondary nerves, and the occasionally obscure tessellation of the leaves, afford good marks of distinction.

28. A. MICROPHYLLA, Munro. Foliis parvis, lineari-lanceolatis vel fere lanceolatis, 1–2 lin. latis, sub 1 poll. longis, *brevimucronatis*, margine submembranaceo fimbriato vel glabro, vaginis striatis subhirsutis apice longe fimbriatis.—*Bambusa microphylla*, Griffith, Jour. i. 242, 259 et alibi (nomen tantum).

Hab. Bootan, Sanah, alt. 7000 p. s. m., no. 623!, aliisque locis ad alt. 6000–10,000 p., *Griffith*, v. s.

Culmus 2–4-pedalis, cæspitosus, internodiis 2–3 poll. longis, glaberrimis, ramulis ad nodos crebris semiverticillatis. *Folia* angusta, membranacea, lineari-lanceolata, acuta, subtus pilis longis hirsuta vel plerumque glabra, nervis secundariis utrinque 2 vix conspicuis, venulis transversis crebris vix elevatis. *Vaginæ* sæpe coloratæ, superne hirsutæ, apice ciliis longis fimbriatæ, ligula subinconspicua.

Griffith, in his account of his journey from Assam to Bootan, constantly refers to this plant as growing at considerable elevations, and "forming large patches in wet places." In describing the vegetation of the Dhonglaila Pass, he says, "the sward commences at 10,000 feet, and is common at 9500, where it is principally clothed with the *Bambusa microphylla*." This and the preceding species have the smallest leaves of all the Bamboos I am acquainted with.

** Folia subtus vix distincte tessellata, venulis transversis paucis distantibus vel subobsoletis.

29. A. SUBERECTA, Munro. Foliis lanceolato-linearibus, angustis, sub 3 lin. latis, 2–3 poll. longis, utrinque glabris, venulis transversis quam minime conspicuis, vaginis striatis, glabris, apice longe fimbriatis et sæpe biauriculatis.

Hab. In Himalaya, in montibus Khasiæ, Moosmai-Churra, alt. 4000 p. s. m., *Griffith*, no. 558!; Kalapanee, alt. 4500 p. s. m., *Hooker*, no. 1407! v. s.

Culmus "10–15-pedalis, suberectus, nutans," vix fistulosus, internodiis glaberrimis 4–6 poll. longis, ramulis proliferis 5–9 poll. longis ad nodos glabros fasciculatis. *Folia* angusta, subsetaceo-acuminata, basi attenuata, margine uno alterove brevissime serrata, concoloria, nervis secundariis utrinque 3–4, venulis transversis distantibus, vix elevatis, interdum ægre discernendis. *Vaginæ* striatæ, usque ad basin solutæ, glabræ, membrana brevissime ciliata terminatæ, apice longe fimbriatæ vel interdum biauriculatæ, ligula conspicua sat brevi.

This approaches *A. falcata* and *A. Khasiana* in the form and size of the leaves, but it is distinguished from both by the fringe at the top of the vaginæ and the presence of transverse veinlets on the lower surface of the leaves; in this latter respect it approaches *A. Hookeriana*, of which, however, I can scarcely believe it to be a narrow-leaved state. Griffith certainly mentions that he found it growing on the banks of the Moosmai waterfall; and it is well known that plants growing in such situations often assume peculiar forms.

A. SPATHIFLORA, Trin. = *Thamnocalamus spathiflorus*, Munro.

A. STOLONIFERA, Kurz, e "China et Japonia," in Cat. of Plants in Bot. Garden, Calcutta (1865), = *Bambusa puberula*, Miq., fide Miquel in Ann. Mus. Bot. Lugd. Batav. ii. 285, = *Phyllostachys nigra*, Munro, *vide* p. 38 *seq.*

II. THAMNOCALAMUS.

Falconer, MS. (nomen tantum) in herb. Hooker. et herb. Strachey.

Spicula sursum imperfecta, 1½–8-flora, in racemo simplici *spatha vel bractea longissima involucrato*, brevipedicellata. *Glumæ* acutæ, paucinerviæ, spiculis suis vix ⅓ breviores. *Palea* inferior acuta vel longe acuminata, supremam vel æquans vel longe superans. *Squamulæ* 3 fimbriatæ. *Stylus* cito supra basin trifidus. *Caryopsis* linearis vel lagenæformis.

Cæteroquin quoad spiculas ut in *Arundinaria*.

Gramina Himalayana, culmo plerumque tereti suffruticoso vel fere arborescente, nodis vix prominulis. Folia parva vel *inconspicue* vel *conspicue tessellata*, vaginis fimbriatis vel efimbriatis. Inflorescentia *panicula* maxima *decomposita* laxa, ramis gracilibus longis multinodis, ramulis ultimis, ad nodos, racemos 1–4 subsessiles, *spatha ipsis multo longiore velatos*, gerentibus. Interdum in *T. Falconeri* racemi intra spatham basi *multibracteati*, et rarissime circa nodos ramorum dense fasciculati sunt.

The structure of the spicula in this genus is so very similar to that of *Arundinaria*, that I should not have separated the two following species from that genus had I not been persuaded that so excellent a botanist as the late Dr. Falconer must have had good reasons for separating the genus *Thamnocalamus*. Unfortunately I can find no definition of the genus by Dr. F., nor any specimen in flower of either species in his herbarium; but, as I have already stated, it contains numerous specimens, in all stages of growth, of *Arundinaria falcata*, which may therefore be the plant he intended as *Thamnocalamus*. It appears to me that this genus can only be well distinguished from *Arundinaria* by its inflorescence, as described above. The spathes, which sometimes have a foliaceous appendage, are remarkably persistent in *T. spathiflorus*, but much sooner caducous in *T. Falconeri*.

Conspectus Specierum.

Folia inconspicue tessellata, vaginis efimbriatis.
Spicula fere semper 1½-flora . . . . . 1. *T. Falconeri.*
Folia conspicue tessellata, vaginis sæpe fimbriatis.
Spicula 4–8-flora . . . . . 2. *T. spathiflorus.*

1. T. FALCONERI, Hook. fil. MS. Foliis, subtus tantum inconspicue tessellatis, in petiolum sublongum supra sulcatum attenuatis; spiculis glabris, fere semper 1½-floris, in racemo 5–7.—*Bambusoides*, Wall. Cat. 5040! *Bambusa floribunda*, Munro, in herb. Trin. Coll. Dublin.

Hab. In Himalaya: Nipal! *Wallich*; Kumaon, Madhari Pass! alt. 8000 ped. s. m., *Strachey* et *Winterbottom.* v. s.

Culmus suffruticosus, excelsus, fistulosus, internodiis 4–8 poll. longis glaberrimis, ramulis fere filiformibus sed validis, subsemipedalibus, plurimis ad nodos fasciculatis. *Folia* angusta, tenuia, pallida, 3–6 lin. lata, 3–4 poll. longa, petiolata, apice subsetaceo-acuminata, supra striata, subtus utrinque nervis secundariis 2–3, venulis transversis distantibus quam minime conspicuis tessellata. *Vaginæ* glabræ, apice quasi subito abscissæ, efimbriatæ, ligula elongata dorso subhirsuta. *Inflorescentia* omnino generis, ramis primariis pedalibus et ultra, racemis brevibus 10–12 lin. longis, spiculis 3–4 lin. longis, glabris, 5–7, brevissime pedicellatis, fere semper sesquifloris, rarissime 2½-floris. Hi racemi, intra spathas sub 1½ poll. longas sæpe cito deciduas, plerumque basi multibracteati, bracteis extremis brevibus gradatim increscentibus; interdum ad nodos ramorum racemi dense fasciculati sunt. *Glumæ* inæquales, membranaceæ, 1–3-nerviæ, apice fimbriatæ. *Palea* inferior 5–7 nervis, brevimucronata, margine subfimbriata, superiorem bicarinatam dorso sulcatam apice bifidam et ciliatam vix æquans. *Squamulæ* subæquales (1 sublongior), oblongæ, basi nervosæ, apice longe ciliatæ. *Stylus* basi subbulbosus cito in stigmata 3 longa pennata divisus. *Fructus* immaturus lineari-oblongus.

This appears to have been found only twice in flower—once by Wallich, in 1821, in Nepal, but without any specified locality. This specimen was a magnificent one, with a panicle evidently several feet in length. The second occasion was by Strachey and Winterbottom, on one of the lower passes of Kumaon. The leaves are unusually thin, and the abrupt termination of the vaginæ, in a straight line below the petiole, affords a good mark of distinction when the plant is found in leaf only. I am unable to state, from the specimens I have seen, whether the flowering and leaf-bearing culms are generally distinct as in Section 2 of *Arundinaria*. There are two or three short leaf-bearing branches scattered occasionally amongst the flowering ones; but these are not sufficient to indicate the general habit of the plant, although they serve to identify the foliage. The same remark applies also to the following species.

2. T. SPATHIFLORUS, Munro. Foliis utrinque conspicue tessellatis, petiolatis; spiculis hirsutis, 4–8-floris, in racemo plerumque 1–3.—*Arundinaria spathiflora*, Trin. in Act. Petrop. *l. c.* (1835), 617 et icon 350!; Rupr. *l. c.* 114, tab. ii. fig. 5; Steud. Syn. 334. *A. procera*, Wall. MS. in herb. Mus. Brit.! *Bambusa macro*, Wall, MS. in herb. Hook.! "Genus novum *Bambusæ affine*," Wall. Cat. 5041!

Hab. In Himalaya: Nipal! (florigerens), *Wallich*! Kumaon, *Falconer*!; Gurhwal, Dudatoli! alt. 8500 ped. s. m., *Strachey, Munro*!; Simla, Hattu! alt. 8400 ped., *Thomson*!; Sikkim, Singalelah! alt. 10000 ped., *Hooker*; Bootan supra Chupcha in sylvis 9500–10000 ped., *Griffith*! v. s.

Culmus procerus, fistulosus, interdum subsemiteres; internodiis 4–6 poll. longis, lævissimis; ramis 1–1½-pedalibus, lignosis, glabris; ramulis semiverticillato-fasciculatis, coloratis, nitidis, filiformibus sed validis, spithamæis ad pedalibus. *Folia* lineari-lanceolata, 3–4 lin. lata, 2–4 poll. longa, glabra, acuminata, basi in petiolum brevem attenuata, utrinque punctulis exasperata, læte viridia, nervis secundariis utroque latere 3; venulis transversis creberrimis, supra et subtus valde prominulis, diaphanis, interstitiis quadratis. *Vaginæ* striatæ, glabræ, ore *longe ligulatæ*, fimbriatæ vel fere efimbriatæ, ad insertionem petioli brevipilosæ. *Inflorescentia* omnino generis, racemis basi ebracteatis, spathis stramineis 2–3 poll. longis, involutis, maximam partem non nisi e spiculis 2 formatis, quarum altera sessilis, altera pedicellata. *Spiculæ* plus minus hirsutæ, 9–12-lineales, 4–8-floræ, intra glumas distincte pedicellatæ, rhachillæ articulis apice barbatis. *Glumæ* inæquales, membranaceæ, 1–5 nervis, superior (9 nervis fide Trin.) 4½ lin. longa. *Palea* inferior longe acuminata, 8 lin. longa, dorso scabro-hirsuta, 7–9 nervis; superior distincte brevior, bicostata et præterea utrinque et inter costas binervis. *Squamulæ* 3, lanceolatæ, inconspicue nervosæ, vix inæquales, duæ latiores, superne fimbriatæ. *Stylus* cito trifidus (bifidus interdum fide Trin.) in stigmata 3 plumosula. *Fructus* (immaturus) lineari-oblongus vel lagenæformis.

This has apparently never been found in flower except in Nepal, by Wallich, in 1821, which may be accounted for by the fact that no European has since that date visited some parts of Nepal into which Wallich was allowed to send his collectors. I feel considerable doubts about the identity of the plants, in leaf only, from the more western Himalayas, Sikkim, and Bootan. In all of these the vaginæ have much longer cilia, the ligules are shorter, and the leaves are thicker in substance; but I have been unwilling on these grounds alone to create new species.

III. Phyllostachys.

Siebold et Zuccarini, Abh. Akad. der Wiss. Münch. (Math.-Phys. Clas.) iii. 745, t. 5. fig. 3 (1843); Endl. Gen. Pl. Suppl. iii. 58 (1843).

Spicula sursum imperfecta, intra glumas distincte pedicellata, 3–5-flora, flosculo terminali tabescente, minimo, in *spica simplici glumis imbricata* sessilis. *Glumæ* multinerviæ, valde variabiles, inferior plerumque apice foliaceo terminata; superior longitudine varians, rarissime deficiens. *Palea* inferior multinervia, acuminata vel rarius, uti glumæ, in laminam foliaceam extensa, hirsuta vel glabra, superiorem bicarinatam, apice bicuspidatam, æquans vel superans. *Stamina* 3, primum inclusa et *plicata*, dein *longe exserta* et pendula. *Squamulæ* 3, lanceolatæ, apice fimbriatæ. *Stylus* basi simplex, *longe supra basin* in stigmata 3, filiformia, serrulato-plumosa, longe exserta divisus. *Ovarium* longe stipitatum, tunc obovatum et in stylum longe rostratum attenuatum.

Gramina arborescentia, in *Japoniana*, *China* et *Himalaya* crescentia, culmo *semitereti*, nodis prominentibus; ramulis foliiferis semiverticillatis, plerumque multinodosis, interdum brevissimis, apice folia 2 vel pauca gerentibus, basi squamis inanibus serius deciduis obtectis. *Folia* breviter petiolata, pulcherrime *tessellata*, supra glabra vel tactu subaspera, subtus plerumque pallida et sæpe præsertim basin versus pubescentia. Inflorescentia paniculæformis, ramis primariis apice plerumque iterum foliosis, ramulis basi squamis obtectis, ultimis sursum spiculas 2–5 alternas ferentibus.

This well-named genus is readily distinguished from all the *Triglossæ* by its very long style, simple for a considerable distance from the base and then divided into 3 very long revolute stigmas, and by its semiterete stems. The details of the structure of the spiculæ are remarkably well figured in the plate of the Munich Transactions referred to above.

Species floriferæ (*2 tantum cognitæ*).

Spiculæ latæ, glumis inferioribus persistentibus, sæpissime apice in laminam foliaceam extensis. Folia margine uno fimbriata . .	1. *P. bambusoides.*
Spiculæ angustæ, glumis inferioribus cito caducis, plerumque apice simpliciter acuminatis. Folia margine utroque fimbriata	2. *P. Stauntoni.*

1. P. BAMBUSOIDES, Sieb. & Zucc. *l. c.* 745. Culmo superne lævissimo, flavido, foliis plerumque 3–4 poll. longis, supra glabris, margine uno quasi setoso-fimbriatis, spiculis 3–4-floris, glumis in spiculis infimis semper apice foliaceis, bracteis involucrantibus brevibus obtusis.—Steudel, *l. c.* 339; Miquel, *l. c.* 284. *Bambusa reticulata*, Rupr. *l. c.* 148. *B. bifolia*, Sieb. MS. in herb. Zuccarini (var. foliis angustis, ciliis vaginæ obsoletis). β. "forma uberior, foliis vulgo majoribus et spiculis longius pedicellatis." *P. megastachya*, Steud. in Flora, Bot. Zeit. 1846, 21, et *l. c.* 339; Walp. Ann. i. 946. *P. macrantha*, Sieb. et Zucc. in Flora, 34 (teste Miquel). *Bambusa reticulata*, var. *macrophylla*, Rupr. *l. c.*

Hab. in Japonia, *Kæmpfer, herb. in Mus. Brit.* fol. 98! 99! *Langsdorf, Siebold, Pierot, Buerger*!; China, Amoy! no. 2073, *J. de Grijs*; Himalaya, Mishmee, Premsong! *Griffith*; var. foliis latis albo-marginatis, Japonia, *Kæmpfer*, herb. fol. 70! *Veitch*!; ins. Kiusiu, *Pierot*. v. s.

Culmus arundinaceus, elatus (*Siebold*) vel 10–12-pedalis (*Griff.*) inermis, *semiteres, flavidus*, superne lævissimus; nodis prominentibus, glaberrimis; ramis multinodosis, interdum brevissimis, semiverticillatis, iterum ramulosis, ultimis in statu florifero spicas sessiles ferentibus. *Folia* oblongo-lanceolata, basi rotundata vel attenuata, petiolata, apice acutissima, nunc disticho-alterna nunc 2–3 ad ramulorum apices aggregata, plerumque 4–9 lin. lata et 3–4 poll. longa, interdum (teste Miquel), in ramis sterilibus, 3 poll. lata et 1 ped. longa, supra glabra, subtus pallida et sæpe præcipue basin versus pubescentia, *uno margine setoso-ciliata* setis distantibus, nervis secundariis utroque latere 5–6, vel interdum 14 (*Miq.*), venulis transversis creberrimis, pulchre tessellata. *Vaginæ* striatæ, plerumque glaberrimæ, sæpe usque ad basin solutæ, "in apice truncato pubescentes et setis rigidulis, 1–2 lin. longis, demum deciduis (interdum obsoletis) munitæ;" superne uno margine ciliatæ, ligula plus minus conspicua. *Inflorescentia* valde variabilis, sæpe (foliis caducis) aspectu paniculæ subbipedalis amplæ et lucidæ, radiis irregulariter spiciferis, sed (meo sensu) vera terminalis in ramulis ultimis, ima basi bracteis obtusis brevibus et lævibus obtectis, spicis fertilibus 3–5 sessilibus, simpliciter racemosa. *Spica* glumis imbricata, 1–2 poll. longa, spiculis 3–5 fertilibus, interdum, teste Steudel, adjectis infra spiculis plurimis (6–9), repetito involucrantibus, sterilibus. *Spicula* fertilis 3–5-flora, 10–12 lin. longa. *Glumæ* multinerviæ, inferior in spiculis infimis multo major, *apice in laminam foliaceam extensa*, in spiculis (et sæpe spicularum flosculis) supremis brevior et simpliciter acuminata fit; superior, in spiculis infimis brevis, inæquilatera, oblique acuta, gradatim, in eadem spica, longior et bicarinata fit et tandem inferiorem æquat; attamen, in spicula suprema, non raro deficitur. *Palea* inferior hirsutiuscula, nervosa, acuta, raro, uti glumæ, in appendicem foliaceam extensa; superior angustior, subæquilonga, apicem versus bicarinata et bimucronata. *Squamulæ* lanceolatæ, basi attenuatæ, hyalinæ, inconspicue venosæ. *Stamina* 3, filamentis tandem longissimis, antherarum connectivo apiculato. *Stylus* longissimus, primum indivisus, sub anthesin dimidia pars superior in stigmata 3 divisa. *Ovarium* glabrum, basi stipitatum, apice in stylum longum attenuatum.

I believe I am right in referring some flowering specimens of a Bamboo in Kæmpfer's herbarium in the British Museum to this species; but unfortunately they are not in

good condition, and none of the spikes are perfect. I have seen a good and perfect flowering specimen from Amoy; but all the others which I have had access to are in leaf only. From the descriptions given by Miquel and others, taken, I presume, from living plants in Japan, this species appears to vary extremely both in inflorescence and foliage. This I can readily believe, from an examination of the Amoy specimen, which exhibits most interestingly the gradual development of leaves into flower-bearing organs. When this is taking place, it is easy to understand that a great amount of variation is likely to occur. In the specimen I have referred to, the lowest glumes generally and the lowest paleæ occasionally have the appearance of miniature leaves, with vaginæ, ligules and cilia, enveloping, however, perfect fertile spiculæ; as progress is made towards the top of the spike, the ligule first, then the cilia, and finally the leaf-like extension disappears, and the uppermost glumes assume the ordinary shape and form of those organs. The bracteas, however, at the base of the flowering branchlets do not seem to be subject to much change. Griffith's specimen is interesting from the western locality in which it was found; writing of it at p. 38 of his Journals, he says, "Great part of the side of the hill below Premsongs village is covered with a small hard Bamboo, which forms excellent walking-sticks." A leaf-bearing specimen of this plant, without any specified locality being affixed, is attached in Linnæus's herbarium to his *Panicum arborescens*, as already mentioned at p. 22. According to Pierot, Buerger, and others, this species appears to bear the Japanese names of Kuma Sasa, Kura Take, and Higama Take. *Bambusa kumasasa* of Zollinger, Steudel, and others is certainly a different species, which I have called *Phyll. kumasaca*. Moreover Siebold, in his account of the economic plants of Japan, in the 12th volume (1830) of the Batavian Transactions, when describing 16 species of Bamboo under their Japanese names, says that all arboreous Bamboos are called "Take" or "Metake," and all herbaceous ones "Sasa;" whereas this species is stated to bear both affixes.

2. P. Stauntoni, Munro. Culmo superne striato, viridi, foliis 1–2½ poll. longis, supra tactu asperis, margine utroque fimbriato-serratis, petiolis supra subtusque hirsutis, spiculis 2–3-floris, glumis caducis, bracteis longis membranaceis.

Hab. China! *Sir G. Staunton.* In herb. Hook. ex herb. Brown. v.s.

Culmus gracilis, fistulosus, superne sulcato-striatus, viridis, semiteres, uno latere canaliculàtus. *Folia* lineari- vel oblongo-lanceolata, apice acuta, basi attenuata in petiolum brevem hirsutum, 2–3 ad apices ramulorum locata, 4–6 lin. lata, 1–2½ poll. longa, utroque margine setoso-fimbriata, subconcoloria, supra tactu aspera, subtus basin versus tantum pubescentia, nervis secundariis utroque latere 2–4; venulis transversis creberrimis, conspicuis, elevatis. *Vaginæ* striatæ, superne pilis paucis hirsutæ, apice membrana ciliata terminatæ, auriculisque duabus ciliis sublongis persistentibus fimbriatis appendiculatæ. *Inflorescentia* (foliis omnibus caducis) paniculæformis, flexuosa, internodiis apice *hirsutis*, ramis iterum ramulosis, ultimis (basi bracteis longis hyalinis acutis velatis) spicas 1–3 subsesquipollicares gerentibus. *Spiculæ* in spica 3, subdistantes, 2–3-floræ, flosculis 1–2 infimis fertilibus, 6–9 lin. longæ, pedicellis rhachillæque articulis hirsutis. *Glumæ* cito caducæ, inferior interdum appendice foliacea terminata, ambæ plerumque acuminatæ, sæpe flosculis breviores et apices versus hirsutæ. *Palea* inferior multinervia, superne hirsutissima, apice attenuata et mucronata; superior brevior, basi *biauriculata* bicarinata, superne hirsutissima, apice profunde bifida. *Stamina* imperfecta.

Squamulæ 3, inæquales, 1 multo minor, lanceolatæ, apice longe fimbriatæ. *Stylus* basi subbulbosus, primum simplex, demum superne in stigmata 3 divisus. *Ovarium* immaturum longe stipitatum, in stylum attenuatum.

In the only specimen I have seen, which was collected, I presume, in Lord Macartney's expedition in 1792, almost all the lower glumes have fallen, and scarcely a single spicula is perfect.

Duæ sequentes, tantum steriles cognitæ, culmo semitereti et habitu peculiari, probabiliter *Phyllostachyos* species sunt.

3. P. NIGRA, Munro. Culmo superne nigrescente, subsolido, foliis angustis, fere lineari-lanceolatis, vaginis ore appendiculato-fimbriatis.—*Arundarbor nigra*, Rumph, Amb. iv. 17? *Bambusa nigra*, Lodd. Cat. (1823); Rœm. et Sch. *l. c.* vii. 2. 1355; Lindl. in Penny Cyclop. vol. iii. (1835); Rupr. *l. c.* 147; Steud. *l. c.* 331. *B. puberula*, Miq. in Ann. *l. c.* 285. *Arundinaria* (*Phyllostachys*) *stolonifera*, Kurz, MS. et Cat. Hort. Bot. Calcut. 79 (1865). *A. diversifolia*, Kurz, MS. *fide* Miq. *l. c.*

Hab. China, Japonia! *Siebold, Buerger, Textor*; ins. Niphon Osakka in oryzetis, *Pierot*. In hortis Europæ, Chinæ et Indiæ orientalis culta. v. v. et s.

Culmus interdum nanus, 4–5-pedalis, interdum (cultura) 25-pedalis, internodiis brevibus, 4–6 poll. longis, subsolidus, semiteres, uno latere fere plano, superne nigrescens vel nigro maculatus; nodis prominentibus, sæpe rugulosis; ramulis tenuibus sed validis, multinodosis, "apice conferte (vulgo) paucifoliis," ultimis, basi, bracteis obtusis gradatim elongatis stipatis. *Folia* lineari-lanceolata, apice acuminata, basi rotundata vel attenuata, breviter petiolata, margine uno vel utroque setoso-ciliata, plerumque 2–3 poll. longa et 4–6 lin. lata, interdum (teste Ruprecht) 4–6 poll. longa et 6–10 lin. lata, membranacea, supra glabra, subtus parum pallidiora et sæpe tota superficie pubescentia, semper basin versus secus nervum medium pilosula, nervis secundariis 3–5–7, venulis transversis creberrimis. *Vaginæ* striatæ, sursum subdilatatæ, superne margineque puberulæ vel tandem glabrescentes, membrana ciliata terminatæ, oreque ciliis paucis, sublongis, demum deciduis fimbriatæ, ligula ovata, obtusa, brevisetosa, plus minus producta.

The leaves in this species are much thinner than in any other of the genus; and although they vary much as to pubescence, the midrib is invariably hairy on the underside towards the base, as is the case in *Arundinaria falcata*. Rumph states that he had never seen specimens exceeding 6 feet in height; and Ruprecht states that it only grows 4–5 feet high, although he assigns to it a diameter of 2 inches. However, there was a very fine specimen in the Crystal Palace, 25 feet high, which I have seen and examined; but unfortunately it was one of the numerous splendid plants destroyed in the late disastrous fire. The stems, although slender, are nearly solid, and appear to be generally used for such purposes as require great strength and toughness. Chairs, pipe-stems, and walking-sticks are often seen in England made from the culms of this species. Miquel, in the 'Annales' referred to, gives no less than fifteen Japanese names for this plant, and says that it varies very much. I cannot, however, understand his remark, "Haud longe distare videtur *Bambusa stricta* Roxb.," unless it has reference to the culm being nearly solid. No two plants can be much more unlike in appearance.

4. P. KUMASACA, Munro. Culmo semitereti, superne pallido, *ramis apice* 1-*foliatis; vaginis brevissimis, fere obsoletis.*—*Bambusa kumasaca*, Zoll. Herb. Steudel. *l. c.* 331; Miq. Fl. Ind. Bat. iii. 419; Ann. *l. c.* 286.

Hab. Japonia, *Siebold, Buerger*! *Veitch*!; ins. Kiusiu, Surasi ("Ko-sasa" incolis), *Pierot*. In Java cult., *Zollinger*. v.s.

Culmus (pars superior sesquipedalis tantum adest) fere simplex, flexuosus, internodiis glabris, pallidis, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, nodis prominentibus. Rami $\frac{1}{2}$–$1\frac{1}{2}$-*pollicares*, terni vel quaterni, fasciculati, 2–3-*nodosi*, basi bracteis membranaceis, ramis ipsis (foliis exceptis) longioribus, bracteati, *apice* 1-*foliati*, "rarius pauciramulosi, paucifoliati." *Folia* oblonga vel ovato-lanceolata, 2–4 poll. longa, 5–10 lin. lata, spinoso-acuta, basi in petiolum, dorso carinatum, 3 lin. longum attenuata, marginibus spinoso-serrata, supra glabra, subtus vix pallidiora, pubescentia vel demum glabrescentia, nervis secundariis utrinque 6–7; venulis transversis creberrimis, punctulis minutis subasperatis. *Vaginæ* brevissimæ, vix $1\frac{1}{2}$ lin. longæ, apice truncato, ciliatæ, ligula fere obsoleta. "Species singularis," "peculiaris certe formationis et vix dubie distinctum genus" (Steud.).

This is certainly unlike any Bamboo I have seen. The branches in the specimens which I have had access to, although divided into 3 internodes, do not exceed $\frac{1}{2}$ an inch in length, and bear a single leaf at their extremity. However, from the general appearance of the plant, I feel persuaded that it belongs to *Phyllostachys* or a closely allied genus.

IV. ARTHROSTYLIDIUM.

Ruprecht, *l. c.* 117; Steudel, *l. c.* 335.

Spiculæ sursum deorsumque imperfectæ, sæpe cylindricæ, multifloræ, pedicellatæ vel sessiles, distantes vel approximatæ, in *racemos simplices* vel *paniculatos* dispositæ, rhachillæ articulis semper comparative longis, flosculis sæpe cito *articulatim secedentibus*. *Flosculi* 1–2 inferiores 1-paleacei, neutri, sequentes perfecti, terminales 1–2–3 tabescentes. *Glumæ* 2 breves vel brevissimæ. *Paleæ* inferiores sæpe acuminatæ. *Squamulæ* 3 fimbriatæ, obtusæ vel acuminatæ. *Stamina* 3. *Styli* 2, basi plerumque conspicue discreti (laterales fide Grisebach), stigmatibus pilosis vel plumosis. Ovarium glabrum, oblongum.

Gramina Americæ æquinoctialis et insularum Indiæ occidentalis incolæ, arborescentia vel suffruticosa, foliis latis vel angustis vel minimis, foliorum costa inferne tantum conspicua, nervis secundariis subobsoletis, venulis transversis nullis.

This genus, which derives its name from the peculiar readiness with which the perfect flowers, except perhaps the lowest, fall off in the spicula, is not in that way to be distinguished from some species of *Arundinaria*; but the lower barren flower, with only 1 palea, keeps it well distinct from that genus. It does not approach any other genus of the "Triglossæ," except *Aulonemia* Goudot, which is scarcely to be distinguished except by its peculiar habit and long loose spreading diffuse panicle.

Conspectus Specierum.

Sect. I. Panicula decomposita, spicis pluribus fasciculatis.

Vaginæ fimbriatæ. Spiculæ conformes	1. *A. Hænkei.*
Vaginæ efimbriatæ. Spiculæ heterogeneæ	2. *A. maculatum.*

Sect. II. Racemus fere simplex, vel raro semel compositus.

Spiculæ longæ, 1½ poll. et longiores.

Folia lata	3. *A. longiflorum.*
Folia angusta	4. *A. Schomburgkii.*

Spiculæ minores, subdistantes.

Folia lata	5. *A. excelsum.*
Folia angusta, supra pubescentia, 3–5 poll. longa	6. *A. pubescens.*
Folia angusta, subtus pubescentia, 1–2 poll. longa	7. *A. Burchellii.*
Folia angusta, glabra	8. *A. Cubense.*
Folia capillacea.	9. *A. capillifolium.*

Spiculæ minores, approximatæ, fere imbricatæ.

Racemus 5–8 poll. longus	10. *A. fimbriatum.*
Racemus vix 2 poll. longus, spiculis pubescentibus	11. *A. racemiflorum.*
Racemus 1½ poll. longus, spiculis glabris	12. *A. Trinii.*

1. A. HÆNKEI, Rupr. *l. c.* 117, tab. iii. fig. 12. "Foliis ovatis, latis, vaginis fimbriatis; spiculis conformibus, longe pedicellatis, basi attenuatis, sub-5-floris."—Steud. *l. c.* 335.

Hab. Peru, *Hænke.* s. v. Ruprecht.

"*Internodia* glabra, crassitie pennæ anserinæ. *Folia* ovata, 3½ lin. lata, fere pedalia, basi rotundata, brevipetiolata (1–2 lin.), chartacea, viridia, ad margines non nisi scabra. *Vaginæ* glabræ, auriculato-fimbriatæ. *Panicula* terminalis, subpedalis, pyramidalis, e spicis pluribus fasciculato-racemosis patentibus. *Spiculæ* 7–8-floræ, longe pedicellatæ, distantes, sub 6 lin. longæ, conformes, basi attenuatæ; flosculis opacis (non nitidis), nervosis, acutis. *Palea* floris inferior obtusiuscula. *Squamulæ* apice tantum longe fimbriatæ."—*Rupr.*

In the diagnosis Ruprecht says, "Vaginæ eligulatæ sunt;" in a note he says, "ligula ½–1-poll. lacera membranacea."

2. A. MACULATUM, Rupr. *l. c.* 118, tab. 5. "Foliis ovato-lanceolatis, vaginis efimbriatis, spiculis *heterogeneis*, pedicellatis."—Steud. *l. c.* 336. *Guadua parviflora*, Presl in Reliq. Hænk. i. 257; Kth. Enum. 434. *Bambusa parviflora*, Rœm. et Sch. *l. c.* 1349.

Hab. In Peruviæ montibus Huannoccensibus, *Hænke.* s. v. Ruprecht et Presl.

"*Internodia* crassitie pennæ anatinæ, ultrapedalia, glabra, ad nodos scabriuscula. *Rami* ad nodos solitarii, 1–2-pedales, paniculam cum foliis 3–5 gerentes. *Folia* ovato-lanceolata, majora 1–1½ poll. lata, 8–9 poll. longa, petiolo vix lineam longo scabro insidentia, apice in acumen longum producta, basi attenuata, margine retrorsum spinuloso-scabra. *Vaginæ* striatæ, scabriusculæ, efimbriatæ, apice utrinque in auriculam culmo adpressam protractæ. *Ligula* ½–1 poll. longa, lacera, membranacea, alba. *Panicula* terminalis, 10–12-pollicaris, erecta, patens, spicis pluribus fasciculato-racemosis, rhachi striata, glabra. *Spiculæ* pedicellatæ, distantes, 4–6 lin. longæ, heterogeneæ, in apice ramorum superiorum fœmineæ perfectiores, flosculis bivalvibus, maculis coloratis adspersis, obtusis; reliquæ masculæ triandræ, acutæ, macriores, glumis et floribus inferioribus acuminato-subulatis. *Palea* superior inferiorem æquans, binervia, bicarinata, glaberrima, obtusissima. *Squamulæ* oblique acutæ, apice fimbriatæ."—*Ruprecht et Presl.*

Ruprecht, in the figure above quoted, gives very full details of the structure of the curious spiculæ of this plant. I have already mentioned, at page 26, that *Arundinaria Trianæ* approaches this in some respects, especially in the heterogeneous spiculæ.

3. A. LONGIFLORUM, Munro. (Tab. I.) Racemo simplici; spiculis plurifloris, *longissimis*; foliis latis, glabris, vaginis ore longissime fimbriatis.

Hab. Venezuela, Colonia Tovar! 6000 ped. s. m., *Fendler*, 1621! *Moritz*, 1393! 1685! v. s.

Culmus "mediocris" (Moritz), glaber, fistulosus. *Spatha* fusca, fere glabra, 6 poll. longa, apiculo lanceolato fere pedali. *Rami* floriferi foliiferique ad nodos fasciculati. *Folia* adulta late lanceolata, striata, 8–9 poll. longa, $1\frac{1}{2}$–2 poll. lata (fig. A); plurima, præcipue in ramulis brevibus, minora sunt, $1\frac{1}{2}$–$3\frac{1}{2}$ poll. longa (fig. B); omnia glaberrima, petiolo fusco, glabro vel piloso, subito petiolata sunt. *Vaginæ* striatæ, apice ciliis validis, basi latis, longissime fimbriatæ. *Racemus* in culmo vel ramulis lateralibus terminalis, spiculis 6–12, sessilibus, approximatis et rhacheos internodiis multo longioribus. *Spicula* plusquam 2 poll. longa, 10–14-flora, lævissima, glumis brevibus, vix acuti; flosculis 1–2 infimis unipaleaceis, neutris, reliquis brevioribus (fig. 1); rhachillæ articulis glaberrimis. *Palea* inferior (flosculi fertilis) 6 lin. longa, dorso glabra, convexa, apice attenuata, breviter mucronata, utrinque nervis 1–3 notata (figg. 2, 3), sæpe purpurascens; superior subæqualis, apice pilis comata, bicarinata et inter carinas pulcherrime ciliatas hirsutiuscula (fig. 4). *Squamulæ* 3, subæquales, nervosæ, lanceolatæ, acuminatæ, superne margine fimbriatæ (fig. 5). *Stamina* 3, antherarum loculis apiculatis (figg. 4, 5). *Styli* 2, basi discreti, stigmatibus 2 longis plumosis (fig. 5). *Ovarium* (immaturum) lineari-oblongum, infra apicem nigrescentem constrictum.

One of Moritz's specimens is marked "Nastus Chusquea," H. B. K.; but that is a very different plant, and is *Chusquea scandens*, Kth. Moritz states that this plant is called "Cariza" by the inhabitants; but I find that this same name is used for several (six or seven) distinct kinds of Bamboo. This is a strikingly pretty grass, far surpassing the remainder of the genus in appearance.

4. A. SCHOMBURGKII, Munro. Racemo simplici, spiculis 6–8-floris, 1–$1\frac{1}{2}$ poll. longis; foliis subtus glaucis, longis, angustis; vaginis ore longe setosis.—*Arundinaria Schomburgkii*, Bennett in Linn. Trans. xviii. 562; Steud. *l. c.* 335.

Hab. In Guiana, alt. 6000 ped. s. m., in montibus, ex quibus fluvii Orinoco, Parima et Rio Negro emergunt, *Humboldt, Schomburgh*! v. s.

Culmi cæspitosi, stricti, erecti, 50–60-pedales, diametro $1\frac{1}{2}$-pollicari, tenues, ramosi, apice nutantes, læte virides, lævissimi; rhizomate valido, articulato, subterraneo. *Internodium infimum* sæpe usque 16-*pedale*, sequentia 15–18 poll. longa. *Rami* verticillati, 3–4-pedales, gracillimi. *Folia* lineari-lanceolata, acuminata, glabra, 8–9 poll. longa, 5–6 lin. lata, in petiolum brevem glabrum flavum attenuata, subtus glauca, nervo medio prominente, secundariis 4–5 vix conspicuis. *Vaginæ* glabræ, ore utrinque longe setosæ, ligula brevissima pilosa. *Racemus* simplex, terminalis, 7–9 poll. longus, spiculis paucis (5–6), distantibus, sessilibus. *Spicula* 6–8-flora, glabra, 1–$1\frac{1}{2}$ poll. longa, flosculo infimo neutro. *Glumæ* breves, acuminatæ. *Palea* inferior (flosculi fertilis) 6–8 lin. longa, superne utrinque nervis 2–3, striata, dorso convexa, apice longissime setaceo-acuminata; superior multo brevior, apice acuto nec bifido, pilis comata, fere plana, vix carinata, glabra. *Squamulæ* lineari-lanceolatæ, acutissimæ, *efimbriatæ*. *Stamina* 3, antherarum loculis *setaceo acuminatis*. *Stylus* cito bifidus in stigmata 2 pulchre plumosa. *Ovarium* (immaturum) apice pubescens et attenuatum.

Mr. Bennett's paper in the Linnean Transactions contains a very interesting account, by Mr. Schomburgk, of this species, which is called "Curata" by the natives. The lowest internode, which sometimes attains the extraordinary length of 16 feet, far surpassing that of any other Bamboo known, furnishes the "Sarbican," or blow-pipe through which the poisoned arrows are blown by the natives of Guiana. M. Humboldt states that these "Sarbicans" are much prized by their owners, and are often handed down as heir-looms. The plant is said to have a very limited range, and to have been found, after very careful search, in only three localities on the sandstone mountains from which the three rivers mentioned above flow. In the specimen in the British Museum the lowest joint is 12 feet 6 inches long.

5. A. EXCELSUM, Grisebach in Fl. Brit. W. Ind. Isl. 529. Racemo simplici, spiculis sub-6-floris, brevipedicellatis, 6–12 lin. longis; foliis latis, vaginis ciliis deciduis fimbriatis, nodis culmi glabris.

Hab. In ins. Caribbæis, Dominica, *Imray*!; Trinidad! "Las Cuevas Hills, Tocuche," *Grisebach*. v. s.

Culmus 60–80-pedalis, diametro 6–12-poll., *internodiis glabris*, ramis floriferis fasciculatis 3–5 poll. longis. *Folia* lanceolata vel oblongo-lanceolata, acuminata, 3–5 poll. longa, plerumque 9 lin. lata, raro angustiora (3 lin. lata), subglabra, basi rotundata, petiolata, petiolo glabro, margine scabra, nervo medio vix conspicuo, secundariis 5–6. *Vaginæ* striatæ, interstitiis subscabris, glabrescentes, apice ciliis 1–4 lin. longis fulvis deciduis fimbriatæ. *Racemus* simplex, rhachi flexuosa, uno latere sulcata, terminalis, spiculis 6–8 distantibus brevipedicellatis. *Spiculæ* sub-6-floræ, 12–6 lin. longæ, articulis rhachillæ apice fimbriatis, flosculo infimo neutro reliquis subbreviore. *Glumæ* breves, pallidæ, membranaceæ, mucronatæ, fere enerves. *Palea* inferior (flosculi fertilis) nervoso-striata, membranacea vel interdum hyalina, apice subobtusa vel brevissime mucronata; superior longior, apice attenuata, vix bifida, bicarinata, superne carinis ipsoque apice hirsutis. *Squamulæ* 3, lanceolatæ, apice fimbriatæ. *Stamina* 3, antheris obtusis. *Styli* ad basin discreti. *Ovarium* (immaturum) lineari-oblongum, infra apicem constrictum.

This is closely allied to *A. pubescens* and *A. Cubense*. The main rhachis of the raceme assumes a peculiar zigzag appearance, exactly resembling in this respect *Festuca divaricata*, Desf.

6. A. PUBESCENS, Ruprecht, *l. c.* 119, tab. iv. fig. 14. Racemo simplici, spiculis 4–9-floris, 9–12 lin. longis, sessilibus, remotiusculis; foliis angustis, 3–5 poll. longis, *superne pubescentibus*.—Steud. *l. c.* 336; Grisebach, *l. c.* 529.

Hab. In ins. Carribbæis, Trinidad, *Lockhart*!; summis montibus "Tocuche," *Grisebach*; Venezuela, Galipan, *Moritz*, 327!, var. glabra? *Fendler*, 1628! alt. 2000 p. s. m. v. s.

Culmus ——pedalis, internodiis (crassitie ¼ lin.) pedalibus, "pubescenti-asperrimis" vel "scabris," vel demum glabrescentibus; "ramulis floriferis ad basin nonnunquam foliolo uno alterove auctis, et sterilibus foliigeris, spithamæis, subrigidis, erectis divaricatisque, e nodis densissime erumpentibus." *Folia* lineari-lanceolata, 4–9 lin. lata, 3–5 poll. longa, basi rotundata vel parum attenuata, petiolata, viridiuscula, subtus et margine scabra, *superne pubescentia* vel *puberula*, nervis secundariis 3 submomeo-fuscis 2 lin. longis deciduis fimbriatæ. *Racemus* simplex, pedunculatus, in ramulis basi paucifoliatis terminalis, spiculis sæpe distantibus, sessilibus vel brevissime pedicellatis. *Spiculæ*

9–12 lin. longæ, glabræ, 4–9-floræ, chartaceæ, complanatæ, flosculis 1–2 infimis neutris, rhachillæ articulis sulcatis apice glabris. *Glumæ* sublongæ, setaceo acuminatæ, dorso carinatæ, glabræ. *Palea* inferior (flosculi fertilis) lanceolato-acuminata vel mucronata, nervosa, 4 lin. longa, glaberrima; superior vix brevior, dorso canaliculata, apice obtuso pilosa. *Squamulæ* 3, oblongæ, obtusæ, apice fimbriatæ. *Stamina* 3, loculis obtusis. *Styli* fere ad basin discreti. *Ovarium* lineari-oblongum, infra apicem constrictum.

Moritz's specimen is marked as "Cariza" of the inhabitants, a name, as already mentioned at p. 41, given to *A. longiflorum* and many other species. I entertain considerable doubts about the identity of Fendler's specimens, which are in leaf only. The leaves are more glabrous above, and the secondary nerves more numerous and more strongly marked below, than in the Trinidad specimens.

7. A. Burchellii, Munro. Racemo simplici vel *composito*, spiculis distantibus, *longipedicellatis*, *glumis hirsutis*, foliis minimis 1–2–3 poll. longis, *subtus pubescentibus*.

Hab. In Brasilia, Corcovado montes, no. 1434!; Serra de Cubatao, no. 3696! (culmus foliiferus tantum), *Burchell.* v. s.

Culmus 6–8–10-pedalis, apice filiformis, tenuissimus, internodiis superioribus 7 poll. longis, apices versus punctis elevatis scabris. *Rami* plerumque basi 2–3-nodosi, geniculati, reclines, ad nodos dense fasciculati, ramulis florigeris numerosis, basi nudis, apice paucifoliatis, 6–10 poll. longis. *Folia* angusta, lineari-lanceolata, 1–2 vel raro 3 poll. longa, 1 3 lin. lata, petiolo supra hirsuto vel glabro sæpe nigrescente petiolata, supra tactu scabra, subtus plus minus dense pubescentia glaucescentia, margine scabra, nervis secundariis inconspicuis. *Vaginæ* in ramulis floriferis, glabræ vel punctis minutis subexasperatæ, ore ciliis pallidis longis numerosis fimbriatæ. *Racemus* vix e vagina suprema exsertus, simplex vel ramis inferioribus 1–2 compositis, 1–2 poll. longus, spiculis distantibus, longipedicellatis, refractis, *pedicellis hirsutis*. *Spicula* pauciflora? flosculis omnibus (in speciminibus visis), nisi infimo fertili, delapsis. *Glumæ* hirsutæ, nervosæ, ovatæ vel oblongæ. *Palea* inferior 5–7-nervis, attenuata, subobtusa; superior sublongior, dorso profunde canaliculata, apice hirsuta. *Squamulæ* oblongæ, dorso hirsutæ, nervosæ, fimbriatæ. *Stamina* 3, loculis subobtusis. *Stylus* ad basin, tandem callosam, indivisus, sed cito supra in stigmata 2 breviplumosa partitus. *Ovarium* basi stipitatum, apice scabrescens et residua styli basi coronatum.

In inflorescence this plant closely approaches many species of *Chusquea*. Unfortunately there is not a single perfect spicula on any of Burchell's otherwise good specimens. Every flower has fallen off from the spicula except the lowest fertile one and the longish pedicel of the following one; and even those which are left are in an imperfect state. I cannot always perceive the lowest neutral floret, the presence of which would principally keep this species distinct from *Arundinaria*, to which genus better specimens may prove it to belong.

8. A. Cubense, Rupr. *l. c.* 118, tab. iv. fig. 13. "Racemo simplici, spiculis subapproximatis, sessilibus, 4–5-floris; foliis 3–4 poll. longis, glabris, angustis."—Steud. *l. c.* 336.

Hab. In Cuba, prope Havannam? *Ramon de la Sagra.* s. v. Ruprecht.

"*Culmus* ——pedalis, ramulis foliigeris apice floriferis, ad nodos inferiores, spicis aphyllis 3–4-nis auctis, rigidis. *Folia* lanceolata, 3–4 poll. longa, 4 lin. lata, inæquilatera, basi cordata, petiolata petiolo lineali flavescente, viridia, *glabra*, subtus scabriuscula, nervis secundariis obsoletis. *Vaginæ* inter

nervos obsolete prominulos dense brevipubescentes, margine ciliatæ, ore ciliis lineolibus pallidis fimbriatæ. *Spica* elongata, spithamæa et ultra, basi aphylla aut foliolo aucta, spiculis sessilibus subapproximatis. *Spicula* 4–6 lin. longa, chartacea, glabra, 4–5-flora, in superiore parte ramulorum longiorum polyantha, in ramulis brevioribus oligantha, flosculis duobus infimis neutris. *Glumæ* angustæ, acuminatæ. *Palea* inferior lanceolata, subulato-acuminata, cinereo-obscura, nervosa; superior brevior, obtusa, superne carinis fimbriata. *Stamina* 3, loculis obtusis. *Styli* ad basin discreti. *Ovarium* infra apicem constrictum."—*Rupr. descr. et icon.*

9. A. CAPILLIFOLIUM, Grisebach in Enum. Plant. Wrightian. Cubensium, in Mem. Amer. Acad. Scien. and Arts, new series, vol. viii. 521 (1862). Racemo simplici, spiculis valde distantibus, pedicellatis, *foliis capillaceis.*

Hab. Cuba, "supra arbores et fruticeta scandens," *Wright*, no. 738! v. s.

"*Caulis* scandens, internodiis gracilibus, vix lineam diametro, lævibus, ramulos foliatos, dense fasciculatos vulgo excedentibus. *Folia* flexilia, tenuissima, *capillacea*, 3–6 poll. longa, canaliculata, glabra, margine scabriuscula. *Vaginæ* breves, læves, ciliis albidis flaccidis 1–2 lin. longis ore fimbriatæ. *Racemus* depauperatus, spiculis 1–4, valde distantibus, ramulis terminalis. *Spicula* breviter pedicellata, 2–6-flora, flosculis 1–2 infimis neutris deorsum decrescentibus. *Palea* inferior (flosculi fertilis) lineari-attenuata, apice obtusiuscula, superne nervata, rhachillæ articulis clavatis triplo longior."

The extremely narrow capillaceous leaves distinguish this at once from all the other species of the genus. I imagine this to be the plant referred to by Ruprecht at p. 118 as a peculiar state of *A. Cubense*, where he says, "Singularis adjacet pars culmi sterilis, internodiis 5-poll., lævigatis, ramulis ad nodos densissime compacteque verticillatis, brevissimis (1½-poll.), angustissimis; vaginis 2–3 glabris, ore albido pilosis, in folia (relative) longissima (2-pollicaria), angustissima (⅙ lin.), filiformia, flexuosa productis."

10. A. FIMBRIATUM, Grisebach, *l. c.* 521, racemo 5–7 poll. longo, spiculis *imbricatis*, *glabris*; foliis 2–4 poll. longis, *glabris*; vaginis ore *longissime* fimbriatis.

Hab. In Cuba Orient.: "prope villam Monte Verde in sylvis densis," *Wright*, no. 1554! v. s.

Culmus 1–3-pedalis, ramorum internodiis gracilibus, lævibus. *Folia* lineari-acuminata, basi subito brevipetiolata, glabra, 2–4 poll. longa, sub 2 lin. lata, patentia, margine glabra. *Vaginæ* læviusculæ, ore fimbriis pallidis sub 6 elongatis patentibus inæqualibus (*longissimis* 10 *lin. longis*) fimbriatæ. *Racemus* contractus, terminalis, 5–7 poll. longus, spiculis linearibus, brevissime pedicellatis, imbricatis. *Spiculæ* 3–5-floræ, 6–8 lin. longæ, glabræ. *Glumæ* parvæ, inferior brevissima. *Palea* inferior lineari-acuminata, nervosa.

A low-growing grass, extremely like *Garnotia scoparia* in habit, easily distinguished at sight by the very remarkable long fringes of the vaginæ.

11. A. RACEMIFLORUM, Steudel, *l. c.* 336. Racemo simplici, vix 2 poll. longo, spiculis approximatis, sessilibus, *pubescentibus*, foliis angustis, 1–2 poll. longis, subtus plus minus *pubescentibus*, vaginis fimbriatis.

Hab. Mexico, *Giesbreght*, no. 234, *Liebmann*, 72!; Venezuela?, Colonia Tovar, alt. 6500–7500 ped. s. m., *Fendler*, 1624! v. s.

Culmus gracilis, elegantissimus, cæspitosus, 20–30-pedalis, internodiis interdum pedalibus et ultra, apice hirsutis. *Rami* ad nodos numerosi, verticillati, ramulis simplicibus vel divisis, glabris, tenuibus.

Folia angusta, lineari-lanceolata, acuta, viridi-glaucescentia, 1–2 poll. longa, 1–3 lin. lata, basi subattenuata in petiolum flavescentem pilosum vel glabrum, supra glabra, vel uno latere pubescentia, subtus scabra (*Steud.*) vel, præcipue basin versus, plus minus pubescentia, nervis secundariis inconspicuis. *Vaginæ* pubescentes vel subglabræ, apice parce fimbriatæ. *Racemus* simplex, secundus, arcuatus, terminalis, vix 2 poll. longus, rhachi hirsuta, spiculis pluribus sessilibus fere imbricatis. *Spicula* pubescens, linearis, 2–4–5-flora; flosculo infimo 1-paleaceo, neutro, palea ovata subito mucronata, reliquis breviore. *Glumæ* 2, lineares, distantes, mucronato-acutissimæ, dorso pubescentes. *Palea* inferior (flosculi fertilis) pubescens, acuminata, nervosa. Genitalia evoluta nunquam vidi.

I have never had an opportunity of examining a perfect spicula of this plant; but I believe that it is generally 3-flowered, with only 1 (the intermediate one) fertile. Fendler's Plant has no flowers, and the leaves are more glabrous than in the Mexican specimens, but I believe it to be the same. Fendler says it is found only in the highest mountains of Venezuela. This species is very closely allied to the following:—

12. A. Trinii, Rupr. *l. c.* 119, tab. iv. fig. 15. Racemo simplici, *pollicari*, spiculis approximatis, sessilibus, *glabris*, foliis $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, subtus (basin versus tantum) pubescentibus, vaginis *efimbriatis*.—Steud. *l. c.* 336. *Arundinaria parviflora*, Trin. Act. Petr. *l. c.* 619.

Hab. In Brasilia: Yponema, *Riedel*; Minas Geraes, *Claussen*! v. s.

Culmus valde inanis, ramulis innumeris, filiformibus, tenuibus, erecto-patulis, subsimplicibus, pedalibus, apice floriferis, inferne foliosis, ad nodos fasciculatis. *Folia* angusta, lineari-lanceolata, acuta, glaucescentia, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, 2–3 lin. lata, basi parum attenuata in petiolum hirsutum, margine aspera, supra glabra, subtus (basin versus tantum) pubescentia, costa nervisque secundariis (in tota lamina sub 7) subobsoletis. *Vaginæ* inter nervos prominulos tenuissime undulato-scabræ, superne margine ciliato-scabræ, *efimbriatæ* (fimbriatæ fide Rupr.) breviligulatæ. *Racemus* simplex, terminalis, subpollicaris, spiculis sub 8, approximatis, sessilibus. *Spicula* pallide straminea, 5 lin. longa, subcylindrica, glabra, 3–6-flora, flosculo infimo subulato neutro, palea acuminata 5-nervia, rhachillæ articulis brevibus. *Gluma* inferior linearis, apice scabra; superior longior, 3-nervis, apice acuminata. *Palea* inferior (flosculi fertilis) 7-nervis, attenuata, apice scabro, nervosa, dorso glabra, margine superne tenuissime ciliata; superior subobtusa, longior. *Squamulæ* 3, inæquales, duæ majores, apice attenuatæ et fimbriatæ. *Stylum* et *ovarium* nunquam vidi.

Steudel and Ruprecht both state that it is probable that *Chusquea? leptophylla*, Nees in Linn. ix. 489, may be the same as *A. Trinii*; but I think the size of the leaves alone keeps it distinct. Ruprecht describes this plant as having "vaginæ fimbriatæ;" but that is certainly not the case in Claussen's specimens, which I have seen. This species is evidently very closely allied to the preceding, *A. racemiflorum*, and is principally distinguished by the glabrous spiculæ, of rather different structure, and leaves with decided ligules and no fringe to the vaginæ. Ruprecht's drawing is evidently made from an abnormal spicula, as, in the analysis, one stamen is represented as becoming converted into a style.

V. Aulonemia.

Goudot, Ann. Sc. Nat. 3me sér. v. 75; Steudel, *l. c.* 338.

Spiculæ sursum deorsumque imperfectæ, multifloræ, flosculo infimo neutro unipaleaceo, compressæ, in *paniculis, longe ramosis*, laxis, *divaricatis*, ad ramulorum apicem congestis. *Gluma* inferior 3-nervis,

acuminata; superior 7-nervis, ovato-obtusa et subito breviter mucronata. *Palea* inferior 7-nervis, ovata, subito mucronata, hirsuta, margine ciliata; superior concava, medio quasi plicata, binervia, nervis ciliatis. *Stamina* 3, antheris lincaribus. *Stylus* basi filiformis, cito in stigmata 2 plumosa divisus. *Squamulæ* 3, inæquales, postica brevior, ovatæ, obscure 3-nerviæ, ciliatæ. *Ovarium* sessile, oblongum, glabrum.

Gramen alte scandens, in America australi tropica indigenum, foliis latis, vaginisque longissime fimbriatis. Inflorescentia panicula terminalis, laxa, divaricata.

This genus, consisting of one species, is principally to be distinguished from *Arthrostylidium* by its lax inflorescence.

A. Quexo, Goudot, *l. c.* 75, t. 4. Foliis latis; vaginis glabris, ore ciliis longis numerosis fimbriatis; spiculis longis, paleis inferioribus subhirsutis.—Walp. Ann. i. 947; Steud. *l. c.* 338.

Hab. New Granada, Carthagena! in sylvis frigidis, Venezuela, 3000 p. s. m., *Fendler*, 2496! v. s.

Culmus cylindricus, glaber, striatulus, alte scandens, ramis pendulis. *Folia* plana, late lanceolata, acuta, brevissime petiolata, 10 poll. longa, 2–3 poll. lata, striata, nervis secundariis utrinque 6–7. *Vaginæ* sulcato-striatæ, superne hirsutæ, ore ciliis 6–10 lin. longis numerosis fimbriatæ. *Panicula* fere pedalis, ramis divaricatis, subquadrangularibus, scaberrimis, axillis callosis. *Spicula* sub-10-flora, $1\frac{3}{4}$ poll. longa, rhachillæ articulis glabris, flosculo infimo neutro, palea una obtusa. *Gluma* inferior brevissima hirsuta. *Palea* inferior (flosculorum fertilium) superne nervosa et hirsuta (glabra fide Goudot), margine ciliata, apice rotundata et mucrone apiculata. *Stylus* fere ad basin divisus. Reliqua generis.

This is stated to be called "Queco" by the natives, and to flower in February and March. There is occasionally a very long linear bract at the base of some of the spiculæ.

VI. Merostachys.

Sprengel, Syst. Veg. i. 132; Endlicher, Gen. Plant. no. 907.

Spicula sursum deorsumque imperfecta, vix pedicellata, 3–4-flora, cum rudimento longe (vel in *M. capitata* brevi-)pedunculato, flosculis 2 infimis unipaleaceis neutris (glumis auct.) valde inæqualibus et dissimilibus, 1 vel rarissime (in *M. Clausseni* et *M. speciosa*) 2 sequentibus bipaleaceis, hermaphroditis. Hæ spiculæ vel in spica terminali, subfalcata, simplici, unilaterali solitariæ ternæve, imbricatobiseriatæ vel in capitulum densum aggregatæ sunt. *Glumæ* fere obsoletæ. *Palea* inferior (flosculi fertilis) acuta vel acuminata vel rostrato-acuminata, multinervis, plerumque adpresso-hirsuta, superiorem, dorso profunde sulcatam, vix æquans vel superans. *Stamina* 3 vel abortu 2 (*Nees*). *Squamulæ* 3 membranaceæ, integræ, superne ciliatæ. *Stylus* basi interdum crassus et bulbosus, cito bifidus in stigmata 2 superne dense plumosa vel simpliciter pilosa. *Ovarium* glabrum, sæpe trigonum.

Gramina in Brasilia et Peruvia indigena, arborescentia vel alte scandentia, ramis fasciculatis, plerumque simplicibus, basi sæpe bracteatis, e nodis culmi erumpentibus. *Folia* plerumque lata, breviter petiolata, venulis transversis obscuris, inferne tamen prominulis: "in pagina inferiore, fascia occurrit, singularis, quæ in *M. Kunthii*, ob folia subtus eximie glauca, magis visibilis est" (Rupr.). *Vaginæ* ore nudæ vel fimbriatæ. Inflorescentia terminalis, in sect. i. spica simplex unilateralis, in sect. ii. capitulum densum.

This genus is quite unique in appearance, and may be considered a Chlorideous form of Bambusaceæ. The glumes of Ruprecht are scarcely ever visible; and Sprengel, Nees,

Kunth, and Endlicher have described the two lowest flowers as glumes, and the ordinary spicula as 1-flowered, with a barren terminal rudiment. I am, however, of opinion that Ruprecht is correct in considering ("ex analogia cum Rettbergiis," and several species of *Chusquea*) that the true glumes are reduced to a minimum, and that the apparent glumes are really two barren flowers. Sprengel also suspected that the only species he was acquainted with was diœcous; but I have not seen any indications of such being the case in any of the specimens of the different species which I have examined. In some very rare instances I have observed two perfect hermaphrodite flowers in the spiculæ of *M. Clausseni* and *M. speciosa*, the other portions of the spicula remaining unaltered.

Conspectus Specierum.

Sectio I. Spiculæ in spica terminali simplici, unilaterales.
- Spiculæ ternæ, vaginæ ore fimbriatæ . . . . . 1. *M. ternata.*
- Spiculæ solitariæ, vaginæ ore fimbriatæ.
  - Fimbriis basi æqualibus.
    - Flosculo secundo longe *rostrato*-acuminato, hermaphrodito patente vix breviore . . . . . 2. *M. speciosa.*
    - Flosculo secundo vix acuminato, hermaphroditum adpressum fere æquante . . . . . 3. *M. Clausseni.*
    - Flosculo secundo vix acuto, hermaphrodito fere duplo breviore . 4. *M. brevispica.*
  - Fimbriis *basi plumosis* . . . . . 5. *M. sparsiflora.*
- Spiculæ solitariæ, vaginæ ore nudæ.
  - Flosculis 2 inferioribus glabris . . . . . 6. *M. Neesii.*
  - Flosculis 2 inferioribus pilosis . . . . . 7. *M. Kunthii.*

Sectio II. Spiculæ in capitulum densum terminale congestæ . . . . 8. *M. capitata.*

1. M. TERNATA, Nees in Agros. Bras. 529. Spiculis *ternis*; palea inferiore flosculi fertilis brevissime *mucronata*, scabra, flosculum secundum neutrum duplo superante; vaginis apice fimbriatis.—Kunth, *l. c.* 429; Rupr. *l. c.* 126, tab. x. fig. 28; Steud. *l. c.* 338.

Hab. In Brasilia: in sylvis, alt. 1200–1800 ped. s. m., præsertim super Serra do Mar, prov. St. Pauli, Rio de Janeiro, Minaes Geraes ("Tagaora" incolis), *Martius.* s. v. Nees et Ruprecht.

"*Culmus* 20-pedalis, crassitie 3–5 pollicum, ramis verticillatis, glabris, ramulis florentibus lævibus. *Folia* oblongo-lanceolata, 7–9 poll. longa, $\frac{3}{4}$–$1\frac{1}{2}$ poll. lata, acuminata, basi etiam acuta, glabra, subtus pallidiora, nervis secundariis utrinque 10–11, fascia obsoleta. *Vaginæ* striato-sulcatæ, basi glabræ, apicem versus pubescenti-scabræ, ore breviter (*Rupr.*) vel fibris longis subcirrhosis (*Nees*) fimbriatæ. *Spica* subrecta, 5-pollicaris, exserta, rhachi dorso *glabra*; spiculis ternis, biseriatis, imbricatis, 6-linealibus. *Spicula* lanceolata, patens, flosculo infimo vix $1\frac{1}{2}$ lin. longo, 1-nervi, carinato; secundo hermaphrodito, duplo breviore, mucronato, 9-nervi, pallide fusco, viridi punctato. *Palea* inferior (flosculi fertilis) ovata, 9–11-nervis, brevissime mucronata, pubescenti-scabra, viridi punctata, amplectens superiorem paulo longiorem, glabram, apice tantum scabram. *Squamulæ* 3, obovatæ, apice ciliatæ, albæ, basi subplicatæ ferrugineæ et paullo crassiores. *Stylus* brevis, crassus et fere bulbosus, stigmatibus longis, filiformibus, pubescentibus. *Germen* conico-trigonum, glabrum."—*Ruprecht et Nees.*

The native name "Tagaora" is not peculiar to this species, but is used for two other species of this genus as well as for *Guadua tagaora*, *G. virgata*, *Arundinaria verticillata*,

and, according to Trinius, for *Chusquea pinifolia*, *Nastus barbatus*, *Arthrostylidium Trinii*, and *Schizostachyum capitatum*.

2. M. SPECIOSA, Sprengel, Syst. Veg. i. 564 (1825), non Kunth. Spiculis solitariis, flosculo secundo, pilis fuscescentibus obsito, longe rostrato-acuminato, hermaphroditum hirsutum fere æquante, vaginis ore longe fimbriatis fimbriis basi æqualibus.—Rupr. *l. c.* 126, tab. x. fig. 29; Steud. *l. c.* 338. *M.* (*speciosa* ? Spr.), Nees, *l. c.* 530, descr. ad specim. Spreng. in herb. reg. Berol. *M. cirrhosa*, Nees, MS. (Rupr.).

Hab. in Brasilia æquinoctiali, *Sellow*! v. s.

Culmus ——pedalis, ramulis sub $1\frac{1}{2}$-pedalibus, teretibus. *Folia* superiora ovato-lanceolata, basi inæquilatera, 5–6 poll. longa, sub 1 poll. lata, cito caduca, subtus lævigata, nervis secundariis utrinque 6–8, fascia obsoleta. *Vaginæ* striato-sulcatæ, transversim ruguloso-asperæ, ore fimbriis, inferne æqualibus, rigidis, nitidis, stramineis, longe fimbriatis. *Spica* falcata, 5–6 poll. longa, rhachi hirsuta, spiculis solitariis, imbricatis, secundis, vaginam supremam sæpe duplo superans. *Spicula* 10 lin. longa, flosculo primo lineari-subulato, carinato-uninervi, utrinque adpresse piloso, 3–4 lin. longo; secundo multo majore, ovato-lanceolato, subplano, extus pilis subadpressis fuscis hirsuto, 5–10 lin. longo, 2–3 lin. lato, apicem longe rostrato-acuminatum versus ciliato, hermaphroditum fere subæquante. *Palea* inferior, flosculi fertilis horizontaliter patentis ovato-lanceolata, breviter et subulato-aristata, 8–10 lin. longa, pilis fuscis, rigidis, longis obsita et præsertim apicem versus dense ciliata; superior brevior, mutica vel apice bidentata, glabriuscula vel apicem versus pilis obsita. *Squamulæ* 3, vel abortu 2 (fide Nees), obovatæ, obtusæ, fimbriatæ vel glabræ (*Nees*). *Stylus* cito bifidus in stigmata 2 penicillato-villosa. *Ovarium* lineari-trigonum, glabrum, in stylum attenuatum.

The flattened second sterile flower, placed at a more acute angle with the rhachis than the hermaphrodite one, gives this plant a remarkable appearance, quite distinct from *M. Clausseni*, to which species alone it approaches. I find in one of Sellow's specimens in herb. Bentham the second perfect hermaphrodite flower, which I had first observed in *M. Clausseni*.

3. M. CLAUSSENI, Munro. Spiculis solitariis, flosculo secundo pubescente, apice attenuato, hermaphroditum pubescentem rhachi adpressum fere æquante; vaginæ ore fimbriis basi æqualibus longe fimbriatæ; foliis subtus præcipue basin versus hirsutis.

Hab. In Brasilia: Minas Geraes! *Claussen*; Organ Mont., *Wilkes*! ("Tacuari" incolis), no. 4238! *Miers*. v. s.

Culmus elatus, "50–80-pedalis, diametro 4–5-pollicari, apice pendulus" (*Miers*), internodiis apice scabris; ramis 1–$1\frac{1}{2}$-pedalibus, basi hirsutis, circa nodos dense verticillatis. *Folia* ovato-lanceolata, acuminatissima, basi plus minus inæquilatera et attenuata in petiolum hirsutum subbilinealem, 4–$5\frac{1}{2}$ poll. longa, 10–12 lin. lata, margine serrulato, scaberrima, supra (præsertim uno latere) scabra, subtus (præcipue *basin versus*) *hirsuta*, nervis secundariis utrinque 5–7, inferne conspicuis, venulis transversis interdum vix manifestis. *Vaginæ* superiores subglabræ, margine superne oreque fibris vel fuscis vel albidis, longis, basi æqualibus fimbriatæ. *Spica* falcata, sæpe folio supremo superata, sub 4 poll. longa, rhachi dorso hirsuta, spiculis solitariis, adpressis, dense imbricatis. *Spicula* 8–9 lin. longa, præter rudimentum terminale, 3–4-flora; flosculis 2 interdum hermaphroditis; flosculo inferiore sterili 1–3-nervi, lineari-lanceolato, vix $1\frac{1}{2}$ lin. longo; secundo multi(15)-nervoso, acuto, flosculum hermaphroditum pilis pallidis brevissimis adpressis pubescentem fere æquante. *Palea* inferior (flosculi

fertilis) apice attenuata et nervosa, superiorem breviorem, ad apicem bifidam, hirsutam involvens. *Squamulæ* 3, vix æquales, apice lanceolatæ, brevifimbriatæ. *Antheræ* nigrescentes. *Stylus* basi simplex, cito divisus, stigmatibus vix plumosis.

The leaves in this species are always conspicuously hairy near their base below, and are thus distinguished from all others of the genus. Mr. Miers says that it grows abundantly in the Organ Mountains, hanging in graceful festoons from the height of 50 to 80 feet along the margin of the forests.

4. M. BREVISPICA, Munro. Spiculis solitariis, flosculo secundo vix acuto hermaphrodito fere duplo breviore, vaginis hirsutis ore longe fimbriatis.

Hab. in Peruvia prope Tarapoto!, *Spruce in herb. Bentham.* v. s.

Culmus ——pedalis, ramis fasciculatis, tactu asperis. *Folia* oblongo-lanceolata, sub 4 poll. longa, sub 6 lin. lata, basi vix inæqualia, petiolata, glabra. *Vaginæ* hirsutæ vel apicem versus *hirsutissimæ*, ore fimbriis plurimis stramineis longe fimbriatæ. *Spica* falcata, $1\frac{1}{2}$–2 poll. longa, rhachi viridi, hirsuta, spiculis solitariis, secundis. *Spicula* subcurvata, 6 lin. longa, flosculo infimo sterili brevissimo, secundo hirsuto, nervoso, apice rotundato, brevissime mucronato, hermaphrodito hirsuto subobtuso $\frac{1}{3}$ vel $\frac{1}{2}$ breviore. *Palea* inferior (flosculi fertilis) pilis sublongis fuscis hirsuta, apice vix acuta, superiorem obtusam, basi glabram, apice tantum subhirsutam, subæquans. *Squamulæ* latæ, oblongæ, obtusæ. *Stylus* basi simplex, vix *cito* in stigmata 2 pulchre plumosa divisus. *Ovarium* subtrigynum, apice fere rostratum.

The short spike and very hirsute vaginæ distinguish this at once from all the other species. It appears also to be the only one found out of Brazil.

5. M. SPARSIFLORA, Rupr., *l. c.* 127, tab. x. fig. 32. "Spiculis solitariis, distantibus, flosculis sterilibus hermaphroditum superantibus, fimbriis vaginæ *breviplumosis.*"—Steud. *l. c.* 338.

Hab. in Brasilia, "ad sinum omnium sanctorum," *Riedel.* s. v. Ruprecht.

"*Folia* lineari-lanceolata, 5–7 poll. longa, 7–8 lin. lata, pellucida, subtus glabra, nervis secundariis 6 prominentibus. *Vaginæ* obsolete striatæ, læviusculæ, ore tenuiter fimbriatæ, fimbriis parvis, *inferne brevi-plumosis.* *Spica* exserta, recta, 2–4-pollicaris, spiculis solitariis, *distantibus.* *Spicula* (nondum sat evoluta) 5 lin. longa, flosculis 2 inferioribus (in icone valde inæqualibus) chartaceo-coriaceis, flosculum tertium, subglabrum, involventibus, *eumque superantibus.*"—*Rupr.*

6. M. NEESII, Rupr. *l. c.* 127, tab. x. fig. 31. "Spiculis solitariis, flosculis duobus inferioribus glabris (Rupr.) vel strigosis (Nees), secundo hermaphroditum superante, vaginis ore nudis."—Steud. *l. c.* 338. *M. speciosa*, Nees, *l. c.* 527, non Sprengel nec Kunth.

Hab. in Brasilia, *herb. reg. Berol.* s. v. Nees et Ruprecht.

"*Culmus* (pars crassitie calami communis adest) æqualis, lignosus, tuberculis minutis asperrimus, ramis ex singulo nodo 24–30, adscendentibus, pedalibus, omnibus apice monostachyis. *Folia* lanceolata, sub 4 poll. longa, 10–12 lin. lata, glaberrima, margine scabriuscula, subtus læviuscula, glauca, petiolata, petiolo glabro fuscescente, nervis secundariis utrinque 5–6, fascia obscura. *Vaginæ* striato-sulcatæ, lævigatæ, apice oblique truncatæ, ligulatæ, *ore nudæ.* *Spica* falcata, incurvata, 5–7-pollicaris, rhachi strigoso-sericea, spiculis solitariis, imbricatis, secundis, erecto-patentibus, in juventute vagina inclusa,

ætate e latere erumpens. *Spicula* 7–8–10 lin. longa, flosculis inferioribus glabris (fide Rupr.), extus strigosis (Nees), infimo breviore lanceolato-acuminato; secundo ovato-oblongo, in cuspidem longam aristæformem attenuato, 7–9-nervi, hermaphroditum pilosiusculum subæquante vel superante. *Palea* inferior (flosculi fertilis) ovato-oblonga, subulato-acuminata, coriacea, carinata, fusco-hirsutula, apiceque præsertim villoso-ciliata; superior subæquilonga, lævissima, chartacea, mutica, obtusa. *Squamulæ* 3 obconicæ, truncatæ, apice ciliatæ, albæ. *Stamina* 2–3. *Stylus* bulbosus, apice bifidus in stigmata 2 glabriuscula (Nees), plumosa (Trin.). *Germen* trigonum, glabrum."—*Nees et Ruprecht*; *Steudel, l. c.*, ait, "Video in specimine omnino descriptioni congruente, ad oras vaginarum, setulas rigidas: vix species diversa."

Judging from description alone, I think this species is scarcely sufficiently distinguished from *M. speciosa*, Spreng., the only difference of any consequence being the absence of a fringe at the mouth of the vagina. But Ruprecht had seen specimens of both, which I have not. I must, however, mention that in the text Ruprecht describes both lower neutral flowers as longer than the hermaphrodite one; whereas in his figure 31 the lowest flower is shown to be very much shorter, which it doubtless is.

7. M. KUNTHII, Rupr. *l. c.* 127, tab. x. fig. 30. "Spiculis solitariis, flosculis 2 inferioribus pilosis, secundo hermaphroditum nigro-hirsutum superante, vaginis ore nudis."—Steud. *l. c.* 338. *M. speciosa*, Kth, Rev. Gram. i. 139, 333, t. 79! optima; Enum. 429, Supl. 354, non. Spreng.

Hab. in Brasilia, in sylvis montium pr. Rio Janeiro, *Beyrich.* s. v. Kunth et Ruprecht.

"*Culmus* 20–30-pedalis, ramulis longissimis, glabris, duris, superne foliosis. *Folia* lineari-lanceolata, 6–7 poll. longa, 1 poll. lata, apice angustato-acuminata, basi rotundata, subtus glaucescentia, nervis secundariis utrinque 6–8, undique papilloso-scabris, margineque superiore fascia 2 lin. lata cinerea nitida cincta. *Vaginæ* sulcato-striatæ, glabræ, lævigatæ, ore nudæ, ligulatæ. *Spica* subrecta, 5-pollicaris, spiculis solitariis, secundis, imbricatis, vagina suprema duplo breviore, exserta. *Spicula* 7–8 lin. longa, flosculis 2 inferioribus pilosis, infimo subulato brevissimo, secundo lanceolato, incurvo, setaceo-acuminato, nervoso, hirsuto, hermaphroditum nigro-hirsutum vix æquante vel superante. *Palea* inferior (flosculi fertilis) hirsuta, subobtusa; superior vix brevior, apice bifida, *hirsuta*. *Squamulæ* 3, superne ciliatæ, duæ laterales oblique oblongæ, tertia minor æquilatera. Media inter *M. speciosam* Spr. et *M. Neesii* Rupr."—*Kunth et Ruprecht.*

Sect. II. *Spiculæ in capitulum densum congestæ.*

8. M. CAPITATA, Hooker, Icon. Pl. t. 273, 274 (1840). Spiculis in capitulum glomeratis, foliis latis, oblongis, vaginis ore longe fimbriatis.—*Chusquea fimbriata*? Steud. *l. c.* 338, var. foliis angustioribus. *Chusquea* (*Rettbergia*) *glomerata*, Munro in herb. Trin. Coll. Dublin.

Hab. in Brasilia, Rio Janeiro, *Gardner*, no. 136! *Tweedie*, 1324, *Riedel.* v. s.

Culmus scandens, gracilis, ramulis subpedalibus, multifoliatis, apice capitulum gerentibus, e nodis erumpentibus. *Folia* lata, oblonga, basi valde inæqualia, 4–6 poll. longa, 9–15 lin. lata, acuta, glabra sed tactu aspera, nervis secundariis a tertiariis non discernendis, petiolata, petiolo supra hirsuto. *Vaginæ* superne sæpissime hirsutæ, ore pilis longis validis rigidis rufis fimbriatæ. *Capitulum* densum, 1¼ poll. diametro, multispiculatum, folio brevi quasi involucratum. *Spiculæ* pedicellatæ, 6–7 lin. longæ, flosculis 2 inferioribus neutris, hermaphrodito duplo brevioribus. *Flosculus* infimus sterilis,

5-nervis, carinatus, in subulam longam scabram abrupte acuminatus; secundus similis, sed longior et 7-nervis. *Palea* inferior (flosculi fertilis) 17–19-nervis, apice longe rostrato-acuminata, plerumque dorso subglabra, sed semper ad margines pilis fuscis hirsuta; superior sublongior, bicarinata, carinis ciliatis vel hirsutis, utroque latere 4-nervia, apice plus minus conspicue bifida. Flos terminalis 1-paleaceus, magis evolutus quam in reliquis speciebus, pedicello brevi. *Squamulæ* 3, lanceolatæ, superne fimbriatæ, inæquales, duæ latiores, fere enervosæ. *Stylus* basi simplex, stigmatibus superne divergentibus. *Ovarium* immaturum.

The details of the structure of this curious species are remarkably well represented in Sir William Hooker's drawing above quoted, although I do not find the squamulæ united at the base as there shown. There are occasionally some abortive spiculæ mixed with the others; and sometimes, indeed often, both paleæ of the fertile floret have green herbaceous points, which in the upper palea are sometimes remarkably divergent; and in those cases it is considerably longer than the lower palea. Gardner says this grass is common in low woods about Rio, rising to a considerable height, climbing among and supporting itself on the branches of shrubs amongst which it grows. I have but little doubt that this is Steudel's *Chusquea fimbriata*, which, at any rate, is certainly not a *Chusquea*, in consequence of the terminal incomplete flower.

Duæ sequentes, tantum absque floribus notæ, ægre discernendæ sunt.

9. M. Sellovii, Munro. "Culmo primario exasperato, vaginis ore herbaceo-barbatis, foliis glaucescentibus serrulato-scaberrimis."—Nees, Agr. Bras. 531, adnot. iii.; Rupr. *l. c.* 127, adnot.

Hab. Paraguay in acumine montis Cabo do Butucaray, *Sellow.* s. v. Nees.

The herbaceous beard to the vaginæ, which, I confess, is a term I do not quite understand, appears to keep this distinct from other species, although Nees considered it might be a young state of one of the three he has described.

10. M. Burchellii, Munro. Foliis lineari-lanceolatis, 1–3–5½ poll. longis, 7–9 lin. latis, supra glabris, subtus glaucescentibus, glaberrimis sed punctulis minutissimis tactu subasperis, vaginis glabris, superne uno latere oreque fibris pallidis longis fimbriatis.

Hab. in Brasilia australi, pr. Santos ("Taquārra vel Taquārri miri" incolis), no. 3243! *Burchell.* v. s.

"*Culmus* solidus vel farctus (maturus cavus est), gracilis, 30–40-pedalis, apicem versus flagelliformis, pendulus, non ramosus sed verticillatim ramulosus" (Burchell), internodiis supremis filiformibus, vix ¼ lin. diametro, pilis reversis per totam longitudinem asperrimis. *Rami* vel ramuli (fide Burchell, 10–12) foliiferi tantum visi, basi strigoso-hirsuti et bracteis imbricati, apice 4-foliati, 6–9 poll. longi, diametro culmum superantes, ad nodum quemque semiverticillati. *Folia* (ramorum) infima pollicaria ovato-lanceolata, superiora lineari-lanceolata, fere setaceo-acuminata, basi attenuata in petiolum brevem nigrescentem, margine aspera, supra glabra sed nervis 2–3, margine uno setulis brevissimis subasperis, subtus glaucescentia, glaberrima, punctulis minutissimis vix tactu aspera, nervis secundariis utroque latere 7. *Vaginæ* subglabræ, superne uno margine oreque fibris pallidis longis, sæpe subcirrhosis, fimbriatæ.

The internodes which I have seen of this species are extremely rough to the touch,

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and not thicker than packing-threads, although they have several branches at each node of the usual thickness. This may possibly be a peculiar state of one of the species already described; it appears to me, however, to differ from all the four species which have a simple fringe of longish fibres at the mouth of the vaginæ. *M. brevispica* is distinguished by having hairy vaginæ. *M. Clausseni* has leaves hairy below. *M. speciosa* has longer and broader leaves, with the vaginæ transversely rugose; and, finally, *M. ternata* would appear to differ in having smoother branches, much thicker stems, and longer and broader leaves, with more numerous secondary nerves below.

VII. Chusquea.

Kunth, Syn. Plant. Æquin. i. 252 (1822); Enum. 427; Endl. Gen. Plan. no. 906. *Rettbergia*, Raddi, Agrost. Bras. 17, t. i. fig. 1, Nees in Mart. Fl. Bras. 535. *Dendragrostis*, Nees in Linnæa, ix. 487. *Nasti*, sp., H. B. K., nov. gen. et sp.; Rœm. et Sch. *l. c.* 7. 2. 1360. *Arundinariæ* sp., Nees in Mart. Fl. Bras. 525. *Arundinis* sp., Poir. Encycl.

Spiculæ deorsum imperfectæ, (exc. *Ch. Venezuelæ*) racemo pedicellatæ, intra glumas sessiles, *rhachilla obsoleta*, 3-floræ, vel rarissime in statu abnormali 4-floræ, flosculis 2 (vel in *Ch. oligophylla* subinde 3) inferioribus unipaleaceis, neutris; *terminali bipaleaceo hermaphrodito*. Interdum in *C. andina*, *C. tenella* et *C. capituliflora* spiculæ 4-floræ, flosculis duobus terminalibus perfectis. Interdum (teste Raddi) in *C. Gaudichaudii* "spiculæ monoicæ, masculæ et fœmineæ in eadem panicula sparsæ." *Glumæ* 2, vel fere obsoletæ (*Dendragrostis*, Nees), vel parvæ vel elongatæ (in *C. tenuiflora* et *C. aristata* spiculam æquantes et superantes), membranaceæ, paucinerves. *Flosculi* 2 neutri, 1–7-nerves, plerumque acuti, sæpe mucronati. "Hermaphroditi paleæ 2 membranaceæ, subæquales; inferior subcarinato-concava, acuto-mucronata, plerumque multinervia; superior parinervia, dorso superne sulcato-subbicarinata, emarginato-bifida." *Stamina* 3. *Squamulæ* 3, plerumque obtusæ et apice ciliatæ, membranaceæ, nervosæ vel enervosæ, subæquales. *Styli* 1–2, plerumque ad basin usque discreti, breves, stigmatibus vel pilosis vel interne plumosis vel villosis, pilis ramosis. *Caryopsis* linearioblonga, compressa vel teres, glabra, libera.

Gramina, orbis novi, in Mexico tropica, Panama, insulis Caribbæis, et America australi, tropica et extratropica, usque ad gradum 42° lat. aust.; nunc in locis maritimis, nunc in regionibus montanis excelsis crescentia. *Culmus*, in *Ch. andina* nanus, 2-pedalis, in plurimis suffruticosus vel arborescens, 6–20-pedalis, interdum altissimus, scandens, ramis fasciculatis sæpe pendentibus. *Folia* plerumque angusta et parva, interdum minima, brevissime petiolata et articulata, venulis transversis subtus nullis vel obscuris, vel raro plus minus conspicuis. *Vaginæ* plerumque efimbriatæ, in *Ch. tenella*, *C. simpliciflora*, et forsan aliis fimbriatæ. Inflorescentia *terminalis*, vel racemus subsimplex, vel panicula plus minus depauperata, vel thyrsoidea, vel panicula decomposita, ramis adpressis aut divaricatis, vel in sect. 2 panicula subrotunda, capitulum referens.

I have already, at page 13, referred to the interesting and suggestive fact of the resemblance borne by several species of this genus and its close ally *Planotia* to some species of *Panicum*, occasioned, as I imagine, by the terminal flower of the spicula, as in all Paniceæ, being the most perfect one. I have examined numerous spiculæ of different species of *Chusquea* and *Planotia*, and I have never discovered the least trace of an elongation of the axis into the terminal imperfect flower, which is, I believe, universally, except perhaps in some few genera of Bamboos, found in all other genera of the great tribe of grasses called "Poaceæ" by Robert Brown in his remarks on the Botany of Terra Australis. From the tribe Paniceæ, which contains all the remaining genera of grasses,

Chusquea and *Planotia* are distinguished by having *three* squamulæ, the *two* lowest flowers of the spicula neutral, and the spicula itself articulated above, instead of below, the glumes.

Conspectus Specierum.

Sect. I. Panicula vel simpliciter racemosa, vel plus minus composita et decomposita, *oblonga*, contracta vel divaricata. "Stigmata pilosa" (*Rupr.*). *Chusqueæ* propriæ et *Dendragrostis* (species glumis potissimum minimis), Nees in Linnæa, *l. c.* 486, 487.

Racemus simplex, spiculis 3–5, *pedicellatis*. Folia *lata* . . . . 1. *C. tenella.*
Racemus simplex, spiculis 3–4, *pedicellatis*. Folia *angusta* . . . 2. *C. simpliciflora.*
Racemus fere simplex, spiculis 5–10, *pedicellatis*. Folia *angustissima* . 3. *C. abietifolia.*
Panicula subracemoso-divaricata, simplex, spiculis *sessilibus* . . . 4. *C. Venezuelæ.*
Panicula *brevis*, semel bisve (vel interdum in *C. Cumingii* magis) composita, *ramis adpressis* non patulis.
Glumæ *brevissimæ*, obtusæ. Palea inferior mucronato-acuta . . 5. *C. pinifolia.*
Glumæ *brevissimæ*, obtusæ. Palea inferior *longissime acuminata* . . 6. *C. Purdieana.*
Glumæ *acutæ, conspicuæ*. Folia subtus *non* tessellata . . . . 7. *C. Cumingii.*
Glumæ *longe cuspidatæ*. Folia *tessellata* . . . . . 8. *C. uliginosa.*
Glumæ *breves*, acutæ vel obtusæ. Panicula pollicaris. Culmus bipedalis. Folia *tessellata* . . . . . 9. *C. andina.*
Glumæ *breves*, acutæ vel obtusæ. Panicula 1–3-pollicaris. Culmus 15–20-pedalis. Folia *tessellata* . . . . . 10. *C. culeou.*
Panicula *brevis*, bis terve composita, ramis *laxifloris, patulis.*
Glumæ fere *obsoletæ*. Folia subtus *pubescentia*, angusta . . . 11. *C. uniflora.*
Glumæ fere *obsoletæ*. Folia *glabra, lata* . . . . . 12. *C. Galeottiana.*
Glumæ *breves*, obtusæ vel acutæ. Folia *glabra, angusta* . . . 13. *C. montana.*
Glumæ *acutæ, conspicuæ*. Folia ovato-lanceolata . . . . 14. *C. oligophylla.*
Panicula *elongata*, bis terve *magisve* composita, apice fere spicata, ramis *densifloris*, in *C. aristata* infimis compositis.
Glumæ *breves*. Folia *non* tessellata . . . . . 15. *C. spicata.*
Glumæ *breves*. Folia *tessellata* . . . . . 16. *C. tessellata.*
Glumæ *longissimæ*. Folia tessellata . . . . . 17. *C. aristata.*
Panicula *elongata*, bis terve composita, ramis *laxifloris, vix* patulis.
Glumæ *obsoletæ*. Folia subtus *glabra* . . . . . 18. *C. Fendleri.*
Glumæ *breves* sed conspicuæ. Folia subtus *pubescentia* . . . 19. *C. Dombeyana.*
Panicula *decomposita*, ramis plerumque *brevibus* et patulis.
Glumæ *obsoletæ*. Folia basi *subcordata*, fere *sessilia* . . . . 20. *C. anelytra.*
Glumæ *fere obsoletæ*. Folia *basi attenuata*, petiolata . . . . 21. *C. Wilkesii.*
Glumæ *breves*, obtusiusculæ. Flosculi neutri nervosi . . . 22. *C. scandens.*
Glumæ *breves*, obtusiusculæ. Flosculi neutri fere enerves . . . 23. *C. pallida.*
Panicula *decomposita*, ramis, interdum valde, *elongatis.*
Glumæ inæquales, superior longe acuta. *Rhachis* paniculæ fere *glabra* 24. *C. Mulleri.*
Glumæ *cuspidatæ*, spiculis *breviores*. Rhachis *hirsuta* . . . 25. *C. quila.*
Glumæ *cuspidatæ*, spiculas *æquantes*. Rhachis *scabro-hirsuta* . . 26. *C. tenuiflora.*

Sect. II. "Panicula contracta, subrotunda (raro ovalis), capitulum referens. Folia ramulorum florentium inferiora et superiora decrescentia, his basin capituli arcte involucrantibus. Stigmata villosa, ramosa" (Rupr.). *Rettbergia*, Raddi et Nees.

Glumæ minutæ, *obtusæ*. Rhachis paniculæ *dense pilosa* . . .	27. *C. Sellovii*.
Glumæ *acutæ*, breves. Rhachis *glabra*	28. *C. Gaudichaudii*.
Glumæ *acuminato-subulatæ*, breves. Rhachis dense *pubescens* . .	29. *C. capituliflora*.
Glumæ setaceæ, longæ, *spiculam æquantes*	30. *C. capitata*.

1. C. TENELLA, Nees in Linnæa, ix. 492. Racemo simplici; spiculis 3–5, coloratis, pedicellatis; glumis brevissimis, obtusissimis; foliis *latis*, vaginis *ore fimbriatis*.—Rupr. *l. c.* 121, tab. vi. fig. 17; Steud. *l. c.* 336. *C.* (*Dendr.*) *tenella*, Nees, *l. c.*

Hab. in Brasilia, *Lhotsky, Sellow*! v. s.

Culmus gracilis, internodiis longis, "floriferis quandoque foliis, demum deciduis, interstinctis." *Folia* late lanceolata, 4–5 poll. longa, 12–15 lin. lata, raro angustiora 6–8 lin. lata, inæquilatera, brevipetiolata, glauca, subtus scabra. "*Vaginæ* glabræ, fusco punctatæ, *ore* margineque dense *ciliato-fimbiatæ*, ligula *obliqua* vel *oppositifolia*, elongata, excisa." "*Racemi* basi bracteati, aphylli, e nodis setuligeris culmi fasciculatim erumpentes, falcati, penduli, pollicares," spiculis 3–5 pedicellatis, rhachi glabra. *Spiculæ* oblongo-lanceolatæ, obtusiusculæ, coloratæ, 3–4 lin. longæ, nervoso-costatæ, glabræ. *Glumæ brevissimæ*, obtusissimæ. Flosculi 2 neutri, acutiusculi, inconspicue nervosi, flosculo hermaphrodito scabro, fere obtuso, subduplo breviores. *Palea* inferior 7-nervis; superior 4–6-nervis. *Squamulæ* 3, longæ, ovatæ, apice longe fimbriatæ, basi venosæ, subinæquales, tertia angustior. "Stigmata 2, longa, capillaria, semiplumosa. *Ovarium* lanceolatum, acuminatum."

The specimens of this which I have seen, from Sellow in herb. Hooker. and herb. Bentham., are evidently in an abnormal condition, with small leaves scattered along the internodes, bearing racemes below the leaves, opposite to and above the leaves. The vaginæ are not fringed in these specimens. Nees states that there are sometimes two perfect hermaphrodite flowers in the spicula besides the two sterile flowers.

2. C. SIMPLICIFLORA, Munro. (Tab. II.) Racemo simplici, spiculis 3–4 *pallidis* pedicellatis, glumis brevissimis obtusis, foliis *angustis* inæquilateris, vaginis *ore fimbriatis*.

Hab. in Panama isthmo. "In sylvis densis," *Sutton Hayes*, 661! *Seemann*, 426! *Triana*! v. s.

Culmi 50–80-pedales, scandentes, apice filiformes (fig. B), dumeta fere impenetrabilia formantes, internodiis semper gracilibus, interdum tenuissimis, scabris vel lævibus, 4–6–7 poll. longis. *Ramuli* florigeri breves basi subaphylli, superne folia 2–3 brevissima gerentes, rarissime proliferi circa nodos culmi dense fasciculati, adjectis interdum ramulis foliigeris tantum paucis, 8–9 poll. longis (figg. A, B). *Folia* inæquilatera, apice basique attenuata, margine serrata, vix petiolata, supra tactu scabra, subtus strigosa et basin versus hirsuta, nervis secundariis tota lamina 9, majora $2\frac{1}{2}$ poll. longa et 4–5 lin. lata, minora vix lineam lata et 3–5 lin. longa (fig. B, magn. nat.). *Vaginæ* striatæ, inter strias hirsutæ vel hirsutissimæ, demum glabrescentes, ore margineque longe setoso-fimbriatæ, ligula brevi. *Racemus* brevis, vix pollicaris, simplex, spiculis pedicellatis subpatulis 3–4, rhachi glabra. *Spicula* pallida, acuta, 3–4 lin. longa, inconspicue nervosa, glabra, glumis 2 brevissimis obtusis, interdum hirtis (fig. 1). Flosculi 2 neutri acutiusculi, hyalini, hermaphrodito glabro $\frac{1}{3}$–$\frac{1}{2}$ breviores. *Palea* inferior acuta, hyalina, inconspicue nervosa, superiorem acutam basi 4-nervem (nervis 2 ante apicem evanidis) subæquans (figg. 1, 2). *Stamina* 3, antherarum loculis apiculatis (figg. 2, 3). *Squamulæ* 3, teneræ, longe fimbriatæ, nervosæ (figg. 3, 4). *Stylus* basi simplex, superne divisus in stigmata 2 interne plumosa (fig. 4). *Caryopsis* matura, teres, lineari-oblonga, apice subattenuata, fusca.

In description, this approaches very closely in many respects to *C. tenella*, but it is extremely different in appearance, and may be easily distinguished by its pale-coloured

membranous spiculæ and much smaller leaves. It appears to be very abundant on the Isthmus of Panama, and especially near the Lion Hill station of the Pacific Railroad.

3. C. ABIETIFOLIA, Griseb. in Flora Brit. West-Indian Islands, 529. "Racemo fere simplici, spiculis 5–10 pedicellatis, glumis valde inæqualibus," foliis angustissimis spinoso-acuminatis, vaginis ore nudis.—*Arundo*, no. 5, P. Browne, Civil and Nat. Hist. Jamaica, 139 (teste Grisebach).

Hab. in Jamaica, *Wilson*!; Ind. occid., *Swartz*. Vidi folia tantum in herb. Hooker. s. v. Grisebach.

"*Culmus* alte scandens," internodiis glabris 3–5 poll. longis, 2 lineas diametro, ramulis foliiferis (internodiis 1–3–6 lin. longis) fasciculatis. *Folia* disticha, ½–2 poll. longa, 1½–2 lin. lata, linearia, rigida, subsessilia, glaucescentia, margine cartilagineo serrulato-scabra, apice spinoso-acuminata, nervo centrali subtus prominente, secundariis a tertiariis non discernendis. *Vaginæ* margine ciliatæ, demum glabrescentes, dense imbricatæ, ore biauriculatæ, eligulatæ. *Racemus* brevis, folia æquans, fere simplex, patulus, spiculis 5–10 pedicellatis, pedicellis 1 lin. longis, rhachi angulata scabra. *Spicula* lanceolato-acuminata, 3 lin. longa, glumis valde inæqualibus, inferiore subobsoleta. Flosculi neutri inæquales, inferior glumam superiorem æquans; superior amplectens, 5-nervis, acuminatus, flosculum hermaphroditum lineari-acuminatum puberulum 3-nervem æquans. *Palea* superior bicarinata, acuminata, inferiore paulo brevior.

Having seen only leaf-bearing specimens of this, I have taken the description of the inflorescence and its details from Grisebach. He, however, mentions only "three sterile glumes;" but as the plant, if it is really a *Chusquea*, must have had four, I have presumed that the lowest one was very small and nearly obsolete, and have so described it. The foliage bears a remarkable general resemblance to that of some species of Coniferæ.

4. C. VENEZUELÆ, Steud. *l. c.* 337. "Panicula subracemoso-*divaricata*, simplici, *spiculis sessilibus*, foliis lanceolatis."

Hab. in Venezuela, *Funck* et *Schlim*, no. 494. s. v. Steudel.

Culmus ——, "ramis ad nodos 3–4-nis, supremis binis vel solitariis. *Folia* sparsa, lanceolata, acuta, 1–4 poll. longa, 2–4 lin. lata, brevipetiolata, glaucescenti-viridia, concoloria, tenuistriata, scabriuscula. *Vaginæ* apice fimbriatæ, margine nudæ. *Panicula* subracemoso-divaricata, simplex, rhachi glabra; spiculis 3-floris, 2–5 lin. longis, ad angulos rhacheos *sessilibus*. *Glumæ* membranaceæ, nervosæ, acutiusculæ, flosculis multo breviores. *Palea* inferior 5–7-nervis, acuta; superior (flosculi fertilis) margine ciliata."—*Steudel.*

I know nothing of this plant except from Steudel's description, given above verbatim. It is the only species in the whole genus with sessile spiculæ; and on this account I think it probable that it may belong to the genus *Arthrostylidium*.

5. C. PINIFOLIA, Nees in Linnæa, ix. 490. Panicula semel composita, depauperata, contracta, vix *pollicari*, *glumis minimis obtusis*, palea inferiore mucronato-acuta, foliis *lineari-subulatis pungentibus*.—Trin. in Act. Petrop. *l. c.* 614, icon. 340!; Rupr. *l. c.* 121, tab. ix. fig. 18; Steud. *l. c.* 336. *Arundinaria? pinifolia*, Nees in Agrost. Bras. 525; Kth. Enum. 427. *Ludolphia pinifolia*, Dietr. Sp. 2. 25. *Dendragrostis pinifolia*, Nees in Linn. *l. c.*

Hab. in Brasilia, *Sellow*!; in monte Itacolumi et Serra de Carassa, alt. 5000–6000 ped. s. m., *Riedel*; in altissimis petrosis, Serra do Itambe da Villa et alibi in districtu Adamantum provinciæ Minarum, alt. 3000–4000 ped., *Martius*; Organ Mts. in summis, *Gardner*, no. 5910! v. s.

Culmi 4–6-pedales, solidi, "fruticeta densissima struentes;" internodiis brevibus, 1–2 poll. longis, nigro maculatis, dense ramulis semiverticillatis ad nodos creberrimis, inferne adpressis, stricte arrectis, superne latioribus et dense foliosis tectis. *Folia* linearia, subulato-acuminata, quasi acerosa, rigida, sessilia, ramulorum suprema ultrapollicaria, inferiora breviora, vix lineam lata, utrinque glabra, subtus 7–11-nervia, nervis secundariis a tertiariis vix distinguendis. *Vaginæ* striatæ, lateribus hirsutæ vel demum glabrescentes, apice biauriculatæ, ligula nulla. *Panicula* semel composita, depauperata, linearioblonga, densa, plus minus pollicaris, spiculis distincte pedicellatis, rhachi pedicellisque puberulis. *Spicula* 3-linealis, subfusiformis, obtusiuscula vel acutiuscula, opaca, demum fuscescens. *Glumæ* ovatæ, minutæ, obtusæ. *Flosculi* neutri subæquales, 3-nerves, mucronulato-acuti, sub lente dorso asperiusculi, discolores in specim. e Sellow, concolores in spec. e Gardner, hermaphrodito brevissime strigoso-hispido fere dimidio vel $\frac{1}{3}$ breviores. *Palea* inferior mucronato-acuta, 7-nervis, superiorem obtusam obsolete quadrinervem subæquans vel superans. *Squamulæ* apice fimbriatæ, inferne nervatæ. *Stylus* fere ad basin divisus, stigmatibus plumosulis. "*Ovarium* lanceolatum, in stylum simplicem attenuatum" (Nees).

Trinius states that this is one of the numerous plants called "Taquarra," as I have already mentioned at p. 48.

6. C. Purdieana, Munro. Panicula semel composita, 2–3-pollicari, spiculis *pubescentibus*, glumis brevibus obtusis, palea inferiore flosculi hermaphroditi *longissime acuminata*, foliis angustis subtus *non* tessellatis.

Hab. in Nova Granada, "in humidis Monte del Moro, prov. Velez," *Purdie*. v. s.

Culmus apice nutans, internodiis inferioribus crassis, asperis, spathis hirsutis involutis, semipedalibus et ultra, superioribus gradatim minoribus sub 3 poll. longis, ramulis numerosissimis, sub 8 poll. longis, ad nodos inferiores densissime fasciculatis. *Folia* ramulorum floriferorum lineari-lanceolata, basi attenuata, vix petiolata, apice setaceo-mucronata, margine vix serrata, 1–2 poll. longa, 1–1½ lin. lata, glabra, nervis secundariis utroque latere 2 subtus conspicuis, venulis transversis *nullis*. *Vaginæ* glabræ, sæpe coloratæ, ligula brevi dorso pubescente. *Panicula* terminalis, semel composita, ramulis paucispiculatis, adpressis, sub 2 poll. longa, lineari-oblonga, rhachi scabriuscula. *Spicula* angusta, brevipedicellata, 5 lin. longa, pubescens. *Glumæ* 2, breves vel brevissimæ, obtusæ, coloratæ, hirsutiusculæ. *Flosculi* neutri nervosi, inæquales, superior $\frac{1}{3}$ longior sub 3-linealis, oblongi, apice mucronati, 5–7-nerves, dorso pubescentes vel hirsuti et margine ciliati. *Palea* inferior floris hermaphroditi 5 lin. longa, dorso inferne glabra, superne pubescens, 7–9-nervis, apice subulato-acuminata; superior paulo brevior, fere glabra, superne tantum subbicarinata, apice bisubulata. *Squamulæ* 3, oblique lanceolatæ, nervosæ, toto margine fimbriatæ. *Stylus* cito bifidus in stigmata 2 plumosa.

Purdie says this is called "Carisa" by the natives; but that appears to be a word used for many species, indeed for cane-brakes generally. The long-pointed lower palea distinguishes this from all other species with short glumes.

7. C. Cumingii, Nees in Linnæa, ix. 487. Panicula plerumque semel bisve, raro magis composita, contracta, lineari-oblonga, 1–3-pollicaris, glumis *lanceolatis cuspidatis*, foliis angustis, margine cartilagineo, subtus *non* tessellatis.—Rupr. *l. c.* 122, tab. vii. fig. 19 (tab. ix. fig. 19, dubia); Steudel, *l. c.* 336; Em. Desv. in Gay, Fl. Chili, vi. 448, tab. 83. fig. 1; Walp. Ann. vi. 1044. *Arundo quillinga*, Molina (fide Cuming).

Arundo canila, Mol. (Steud.). "Modum crescendi repræsentat Lütke, Iter, 1835, atl. tab. ii." (Rupr.). *C. parvifolia*, Philippi in Linnæa, xxxiii. 239.

Hab. Chili, Valparaiso, *Cuming*, 639! *Bridges*! *Capt. King*! *Bertero*, no. 816, *Pœppig*, *Kastalsky*, *Wilkes*!; Conception, *Mertens.—Gardner*, 5410! in Hb. Bentham. v. s.

Culmus 8–10-pedalis, erectus, superne nutans, internodiis sub 3–4 poll. longis, lævigatis, stramineis vel purpurascentibus; ramulis patulis, pedalibus vel 2-pollicaribus, basi foliiferis, apice floriferis, dense fasciculatim erumpentibus, "sterilibus quibusdam divaricatis vel flexuosis." *Folia* lanceolata vel lineari-lanceolata, apice mucronato-acuminatissima, plana vel involuta, tenuia vel firma, pungentia, subrigida, sessilia, margine cartilagineo vix serrata, subtus glabra, concoloria, nervis secundariis 2–3 utroque latere, venulis transversis nullis, 1 poll. et ultra longa, $1\frac{1}{2}$–3 lin. lata. *Vaginæ* vix striatæ, glabræ, apice subbiauriculatæ, ligula brevi. *Panicula* lineari-oblonga, $1\frac{1}{2}$–2–3 poll. longa, contracta, plerumque semel bisve composita, interdum magis composita, thyrsoidea, rhachi pedicellisque brevibus tenuiter puberulis, subteretibus. *Spiculæ* sæpe monoicæ, coloratæ vel sæpius pallidæ, ovato-lanceolatæ, nitidæ, obsolete nervosæ, 3–$3\frac{1}{2}$ lin. longæ. *Glumæ* lanceolatæ, cuspidatæ, plus minus carinatæ, rarissime pubescentes, flosculo infimo vix duplo breviores. *Flosculi* neutri inæquales, cuspidati, 3–5-nervibus; superior longior, hermaphrodito, glabro, sæpe colorato, 7-nervi, $\frac{1}{3}$–$\frac{1}{2}$ brevior. *Palea* superior apice obtuso bifida. *Squamulæ* subinæquales, lanceolatæ, basi venosæ, superne fimbriatæ. *Stylus* plerumque cito bifidus in stigmata 2 plumosa.

This plant varies considerably both in foliage and inflorescence. The specimens collected at Valparaiso in Wilkes's Expedition exhibit a very small prostrate form, which I believe to be *C. parvifolia* of Philippi. Ruprecht has given two drawings of the structure of the spicula, which do not agree with each other: plate vii. fig. 19 represents the ordinary state of the plant, and is quite correct in all details; plate ix. fig. 19, bearing the same name, is incorrect in many respects, and the second neutral flower is represented as having two paleæ.

8. C. ULIGINOSA, Philippi in Linnæa, xxx. 207. Panicula bis terve composita, lineari-oblonga, 2–4 poll. longa, ramis adpressis, glumis lanceolatis cuspidatis, *superiore flosculum infimum fere æquante*, foliis angustis subtus *tessellatis*.

Hab. Chili, Valparaiso, Puerto Monti! in uliginosis ("kleine Quila" incolis), *Philippi*. v. s.

Culmus vix 6-pedalis, ramosissimus; internodiis foliiferis glabris, 7 poll. longis, diametro 3 lin., basi spatha striata, adpresse hirsuta, involutis; floriferis sub 5 poll. longis, glabris, tenuioribus. *Ramuli* foliiferi (nondum sat evoluti) sub 3 poll. longi, oligophylli; florigeri fere aphylli, 3–6 poll. longi. *Folia* lineari-lanceolata, basi attenuata in petiolum brevem, apice mucronato-acuta, margine cartilagineo crasso serrata, rigida, glaucescentia, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, 2–3 lin. lata, nervo centrali subtus valde conspicuo, secundariis 2–3 utroque latere, *venulis transversis* plus minus *conspicuis tessellata*. *Vaginæ* striatæ, hirsutiusculæ, apice tenuiter ciliatæ, ore nudæ, ligula conspicua ciliata. *Panicula* bis terve composita, ramis adpressis, lineari-elongata, 2–4 poll. longa, rhachi pedicellisque sublongis angulatis scabriusculis. *Spicula* colorata, ovato-lanceolata, dorso scabra, inconspicue nervata, 3 lin. longa. *Glumæ* inæquales, lanceolatæ; superior longe cuspidata, 3-nervis, dorso scabra, flosculum infimum acuminatum subæquans. Flosculus secundus hermaphrodito 7-nervi subglabro parum brevior. *Palea* superior bicarinata, 6-nervis, inter carinas pubescens. Genitalia carie destructa in speciminibus a me visis.

In many respects this is very closely allied to *C. Cumingii*; but the foliage appears

sufficiently distinct to separate it from that species, in the leaves of which I have never observed any trace of tessellation.

9. C. ANDINA, Philippi in Linn. xxix. 103. Panicula fere simplici, *subunciali*, rhachi pubescente, glumis acutis vel obtusis, flosculo infimo duplo brevioribus, foliis angustis, longe acuminatis, subtus *tessellatis*.—Walp. Ann. vi. 1044.

Hab. Chili, in "Andibus, depart. Chillan ad limitem nivis perpetuæ," *Germain*! v. s.

Culmus erectus, humilis, vix *bipedalis*, ramis fasciculatis, densissime foliosis. *Folia* coriacea, lineari-lanceolata, 13–18 lin. longa, 2–2½ lin. lata, apice longe acuminata, margine coriaceo serrata, subtus 5-nervia, nervo mediano valde prominente, venulis transversis valde conspicuis *tessellata*. *Vaginæ* imbricatæ, striatæ, glabræ, ligula producta, ovata. *Panicula* subuncialis, fere simplex, radiis brevissimis, rhachi dense pubescente, fere villosa, spiculis fere *sessilibus*. *Spicula*, glumis exemptis, glaberrima, nitida, plerumque violacea, 3–3½ lin. longa, interdum 4-*flora*, flosculis 2 superioribus 2-paleaceis et hermaphroditis. *Glumæ* sæpe pubescentes, ovatæ, acutæ vel obtusæ, flosculis neutris, acuminatis, 1–3-nervibus, duplo breviores. *Palea* inferior (hermaphroditi) neutris ⅓ longior, conspicue 7-nervosa, apice acuminata, superiorem subæquans.

This species also approaches very closely to *C. Cumingii*, but is distinguished by its tessellated leaves and dwarf habit. I have never observed in any other species of *Chusquea* two perfect flowers in the spiculæ, although Nees observes that they are sometimes found in *C. tenella*.

10. C. CULEOU, Em. Desv. in Gay, Fl. Chili, vi. 450, tab. lxxxiii. fig. 2. Panicula spiciformi-contracta, 1–3 poll. longa, rhachi hirsuta; glumis plerumque obtusis, flosculo infimo plus quam duplo brevioribus; foliis angustis, subtus tessellatis et sæpe pubescentibus.—Walp. Ann. vi. 1044. *C. breviglumis*, Philip. in Linn. xxix. 103; Walp. *l. c.* 1043.

Hab. Chili, Valdivia, "in sylvis humidis," *Gay, Lechler*, 2920!; "Cordillera de Chillan," *Germain*! (*C. breviglumis*). v. s.

Culmus erectus, 15–20-pedalis et ultra (fide Gay), orgyalis (fide Germain ad *C. breviglumem*, Philip.), robustus, internodiis glabris vel superne scabriusculis, 3–4 poll. longis; ramis erectis, 3–7 poll. et ultra longis, densissime fasciculatis, polyphyllis. *Folia* coriacea, lanceolata vel "lineari-elliptica," apice mucronata sed vix attenuata, basi "nunquam attenuata" vel subcuneata, margine coriaceo, 1–3 poll. longa, 2–3 lin. lata, supra glabra, subtus interdum (non semper) pilis longis hirsuta, nervis 5 conspicuis, medio valde prominulo, venulis transversis crebris plus minus conspicuis tessellata. *Vaginæ* imbricatæ, striatæ, glabræ, ligula ovato-rotundata, producta. *Panicula* stricta, spiciformi-contracta, radiis densifloris, 1–3 poll. longa (1–1½, fide Desv.); rhachi hirsuta, fere villosa, spiculis *subsessilibus*. *Spicula* 2½–3–4 lin. longa, pubescens vel glabra, violacea vel pallida, subacuta. *Glumæ* 1-nerves, pubescentes vel glabræ, inæquales; inferior subobtusa; superior acutiuscula, flosculis neutris acuminatis 3-nervibus plus quam duplo brevior. *Palea* inferior (hermaphroditi) 7-nervis, tenuissime pubescens vel glabra, in apice obtusiusculo mucronata, superiorem æquans. *Squamulæ* inæquales; duæ latiores, basi 3–4-nerves, superne margine pilis longis ciliatæ; tertia angustior, 1-nervis (*Gay in icone*).

This approaches very closely to *C. andina*, which is very probably only an alpine form of this species. It is also nearly allied to *C. Cumingii*; and I am unable to assign any good distinguishing character to *C. breviglumis* of Philippi. The latter appears to be a

dwarfer plant; but that may be accounted for by Germain's specimens having been collected at a considerable elevation above the sea.

11. C. UNIFLORA, Steud. Syn. 337. Panicula *brevi*, *patula*, laxa, glumis fere obsoletis; spiculis obtusiusculis, 2–3 lin. longis; foliis angustis, membranaceis, subtus *pubescentibus*.

Hab. in Nova Granada, Marignita, *Linden*, 893!; Ecuador, Quito, in Andibus, *Spruce*, 5940! v. s.

Culmus "solidus, diametro 1-pollicari, arcuatus, 20-pedalis, sæpe ramosissimus, ramis sarmentoso-imbricatis;" ramulis plerumque 6–9 poll. longis, interdum proliferis bipedalibus, ad nodos fasciculatis. *Folia* lanceolata, acuta, basi in petiolum attenuata, sub 1–2 poll. longa, raro longiora, 2–4 lin. lata, membranacea, supra tactu aspera, subtus pubescentia, nervis secundariis utroque latere 2. *Vaginæ* striatæ, margine, superne præsertim, ciliatæ, ligula elongata pubescente. *Panicula* semel bisve composita, 1½–3 poll. longa, laxa, diffusa, radiis solitariis, radiolis sæpe unispiculatis, in ramulis basi geniculatis (sæpe pendulis) oligophyllis terminalis; rhachi pedicellisque longis, spiculas subæquantibus, punctulis minutis asperis, vel interdum longe pilosis. *Spicula* 2–3 lin. longa, subobtusa, nitida, glumis minimis, fere obsoletis. *Flosculi* neutri subæquales, ovati, brevissime mucronati, inconspicue nervati, hermaphrodito lævi, fere duplo breviores. *Palea* inferior subobtusa, nervosa, *cito dorso* fissa; superior apicem versus bicarinata et bifida. *Squamulæ* lanceolatæ. *Stylus* cito bifidus.

The lower palea soon becomes split into two, and gives a very peculiar appearance to the spicula. Steudel, in describing the plant as with solitary branches, can only have seen one of the very numerous branches that are fascicled together at all the nodes.

12. C. GALEOTTIANA, Rupr. Bull. Brux. ix. 2. 246 (nomen tantum). Panicula patula, laxa, glumis fere obsoletis, spiculis obtusis, 5–6 *lin. longis*, foliis *lato-lanceolatis*, *glabris*.

Hab. Mexico, Oaxaca, 8000 ped. s. m., *Galeotti*, no. 5749! v. s.

Ramuli 12–16 poll. longi, unifoliati (duo tantum adsunt). *Folia* lato-lanceolata, 2–4 poll. longa, 6–10 *lin. lata*, in petiolum attenuata, membranacea, glabra, nervis secundariis utroque latere 3–4. *Vaginæ* striatæ, glabræ, ligula brevissima. *Panicula* laxa, patula, *semel composita*, nutans, rhachi hirsuta, radiis solitariis, radiolis 1–2-spiculatis, pedicellis spiculis (5–6 lin. longis) brevioribus vel raro æquantibus. *Glumæ* minimæ, fere obsoletæ. *Flosculi* neutri subæquales, multinerves (omnes in specimine viso imperfecti), hermaphrodito glabro breviores. *Palea* inferior 9-nervis, vix acuta; superior subobtusa, apice bifida, dorso conspicue canaliculata.—*C. unifloræ* proxima.

The specimens of this are unfortunately imperfect; but it is evidently a good species, with larger spiculæ than any other species of the genus.

13. C. MONTANA, Philippi in Linn. xxxiii. 298. Panicula patula, laxa, glumis brevibus conspicuis, spiculis violaceis; foliis angustis, subtus glabris, margine cartilagineo.

Hab. Chili, Valdivia, in montibus supra Corral, *Krause*! *Philippi*. v. s.

Culmus 6–9-pedalis, ramosissimus, internodiis scabris, ramulis 6–9 poll. longis ad nodos fasciculatis, ramulo uno alterove interdum prolifero polyphyllo. *Folia* lineari-lanceolata, 2–2½ poll. longa, 2–3 lin. lata, glabra, basi attenuata, apice mucronata, margine subcartilagineo, nervis secundariis utroque latere 2, subtus *conspicuis*. *Vaginæ* conspicue striatæ, glabræ, margine ciliatæ, ligula elongata, glabra. *Panicula* laxa, patula, 2–3 poll. longa (4 poll., fide Philippi), semel bisve composita; rhachi angulata, subhirsuta; radiis solitariis; radiolis sæpe unispiculatis; pedicellis spiculas sub 3 lin.

longas, acutas, violaceo-coloratas, pubescentes æquantibus. *Glumæ* breves, obtusæ vel acutæ. *Flosculi* neutri subæquales, conspicue 3–5-nervati, acutissimi, pubescentes, flosculo hermaphrodito nervoso acuto pubescente vix duplo breviores.

This comes very close to *C. uniflora*, Steud., and is really only to be distinguished from it by the more conspicuous glumes and glabrous leaves with a thickened margin, and the secondary nerves very strongly marked.

14. C. OLIGOPHYLLA, Rupr. in Act. Petrop. *l. c.* 124, tab. vii. fig. 23. "Panicula patente, brevi, spiculis pallidis coriaceis, glumis acutis conspicuis, foliis *ovato-lanceolatis, vaginis* inferioribus ad nervos *retrorsum hispidis*."—Steud. *l. c.* 337.

Hab. in Brasilia. s. v. Ruprecht in herb. Mus. Pragensis.

"*Culmi* ——pedales; internodiorum pars inferior setulis nigris divaricatis obsita; spathis persistentibus, 5-pollicaribus, striatis, ad nervos retrorsum hispidis; ramulis subternis, spithamæis, oligo(2)-phyllis. *Folia* ovato-lanceolata, 6 lin. lata, 3 poll. longa, brevipetiolata, viridia, subtus pallidiora glaucescentia. *Vaginæ* inferiores ramulorum quandoque setulis nigris obsitæ. *Panicula* patens, oblonga, rhachi glabra, semel bisve composita, radiolis solitariis paucifloris, spiculis pedicellatis. *Spicula* pallida, opaca, coriacea, 2–3-linealis, subtilissime punctata, terminalis, subinde 4-flora, flosculo tantum supremo bipaleaceo hermaphrodito. *Glumæ acutæ*, flosculis neutris distincte 7–11-nerviis duplo breviores. Hi flosculi hermaphrodito duplo minores. *Squamulæ* subæquales, apice fimbriatæ. *Stylus* ad basin simplex, superne divisus in stigmata 2 intus plumosa. Valde affinis *C. Gaudichaudii*."—*Ruprecht.*

15. C. SPICATA, Munro. Panicula elongata, spicata, rhachi hirsuta, glumis brevibus obtusis; foliis lineari-lanceolatis, basi subcordatis, apice subulato-acuminatis, *non tessellatis.*—*C. humilis*, Lechler MS.

Hab. Peru, Sachapata in Cordillera, *Lechler*, 2154! 2640! 2694! (var. glumis hirsutis). v. s.

Culmus erectus, internodiis vix sesquipollicaribus, ramulis polyphyllis, 14–16 poll. longis, erectis, apice spicigeris, ad nodos dense glomeratis. (Variat humilis, culmus vix 10 poll. longus, basi repens, ramis solitariis.) *Folia* lineari-lanceolata, 2–2½ poll. longa, 2 lin. lata, basi cordata et petiolata, apice longissime subulato-acuminata, glabra, nervis secundariis subtus inconspicuis. *Vaginæ* striatæ, superiores imbricatissimæ, lateribus pubescentibus, inter strias superne discolores vel (in var. *humili*) violaceæ, ligula brevi. *Panicula* spiciformis, 1½–5 poll. longa, basi interdum interrupta, rhachi hirsuta, pedicellis brevissimis. *Spicula* acuta, 1½–2½ lin. longa, plus minus pubescens; glumis brevibus, obtusis, hirsutis vel glabris. *Flosculi* neutri acuminati, subscabri, margine vix conspicue ciliati, hermaphrodito (acuto, apice nervoso et inter nervos pubescente) vix ⅓ breviores.

No. 2154 of Lechler contains portions of a large plant of some height; 2640 and 2694 are from very dwarf plants; but I cannot point out any distinction of consequence. The spike of this plant is extremely like that of *Panicum interruptum*, Willd.

16. C. TESSELLATA, Munro. Panicula elongata, spicata, rhachi hirsuta; glumis brevibus, obtusis, hirsutis; foliis lanceolatis, basi obtusis, apice subulato-acuminatis, subtus conspicue *tessellatis.*

Hab. in Nova Granada, "Andes de Bogota; Paramo de Cruz Verde, alt. 3000 ped. s. m.," *Triana*!; "in montibus ad orient. Bogotæ, Guadaloupe," *Holton*, 97! v. s.

Culmus suffruticosus, erectus, subsolidus, internodiis 1½–2-pollicaribus; ramis paucis, erectis, adpressis, cito divisis in ramulos oligophyllos, 6–16 poll. longos, apice spicigeros. *Folia* lanceolata vel linearilanceolata, 1–2¾ poll. longa, 1½–3 lin. lata, basi obtusa, vix petiolata, apice longissime subulata, margine serrata vel basin versus pilis longis fimbriata, subtus venulis transversis crebris conspicue tessellata et sæpe pubescentia. *Vaginæ* striatæ, hirsutæ, subconcolores, margine sæpe longe fimbriatæ, ligula brevi, hirsuta, obtusa, ciliata. *Panicula* spiciformis, vix basi interrupta, angusta, fusca, 4–6 poll. longa, rhachi hirsuta, pedicellis brevissimis. *Spiculæ* sæpe monoicæ, acutæ, vix 3 lin. longæ, pubescentes vel hirsutæ; glumis brevibus, hirsutis, obtusis. *Flosculi* neutri mucronati, dorso scabriusculo-hirsuti, conspicue nervosi, inæquales; longior hermaphroditum glabriorem superans vel vix æquans. *Palea* inferior mucronata, superiorem fere membranaceam involvens.

This approaches the preceding species, *C. spicata*, in many respects, but is at once distinguished by the conspicuously tessellated leaves. M. Triana says it is called "Carrisa" in Bogota.

17. C. ARISTATA, Munro. Panicula elongata, apice fere spicata, *ramis inferioribus compositis*; glumis *aristatis, longissimis*, flosculos multo superantibus; foliis *lato-lanceolatis*, subtus conspicue *tessellatis*.

Hab. Ecuador, Quito, in Andibus, alt. 13000–15000 ped. s. m., *Jameson*, no. 92! v. s.

"*Culmi* erecti, 5–6-pedales, fruticeta impenetrabilia struentes." (Partem superiorem simplicem tantum vidi.) *Folia* lato-lanceolata, 6–8 poll. longa, 9 lin. lata, glaberrima, basi vix attenuata, subito articulata, apice acuta, margine coriaceo, subtus venulis transversis crebris elevatis conspicue tessellata. *Vaginæ* glabræ, vel juniores hirsutæ, ligula nulla. *Panicula* terminalis, 9 poll. longa, fere jubalis, apice subspicata, radiis inferioribus sub 3-pollicaribus, compositis, subfalcatis, rhachi hirsuta, pedicellis basi glandulosis, brevibus, spiculas vix æquantibus. *Spicula* ovata, (glumis exclusis) vix 3 lin. longa, subpubescens. *Glumæ* 6 *lin. longæ*, enerviæ, basi latæ, attenuatæ in aristam longissimam scabram. *Flosculi* neutri subæquales, acuminati, scabri, fere enervii, hermaphroditum scabriusculum, apice 3–5-nervosum æquantes. *Squamulæ* 3, basi callosæ et multinervosæ, apice lanceolatæ enervosæ. *Stylus* cito bifidus, stigmatibus divaricatis et recurvis.

A very curious grass, resembling some species of *Echinochloa* in general appearance. Jameson says, "It is a tall reedy grass, found only on the Eastern chain of the Andes. At 13,000 feet it first makes its appearance, in irregular patches; at 15,000 feet it completely covers the whole surface, forming what the natives call a 'carizal,' impenetrable to man or beast. It continues upwards nearly to the limits of perpetual snow."

18. C. FENDLERI, Munro. Panicula elongata, angusta, longe exserta, composita, ramis laxifloris adpressis, glumis *obsoletis*, flosculis neutris paucinerviis; foliis angustis, subtus *glabris*.

Hab. Venezuela, in colonia Tovar, alt. 6000–7900 ped. s. m., *Fendler*, 1627!; Ecuador, "a litore usque ad 12,000 ped. s. m.," *Jameson*, no. 9! v. s.

Culmus solidus, diametro basi semipollicari; spathis magnis, longe acuminatis, subsericeo tomentosis; internodiis longis, glabris vel superne scabriusculis. *Rami* basi geniculati, alii foliiferi tantum, segregati, 1–1½-pedales, foliis 5–6, alii floriferi, breviores, foliis 1–2, ad nodos subtumidos fasciculati. Interdum ramuli foliiferi abortivi, brevissimi, cito recurvi, spiniformes fiunt. *Folia* in ramulis foliiferis sub 4 poll. longa, in floriferis brevioribus sæpe 1 poll. et ultra longa, 2–4 lin. lata, lineari-lanceolata, basi attenuata, apice longe setaceo-acuminata, margine longe serrata, glabra, nervis secundariis 6–8 conspicuis. *Vaginæ* glabræ, margine sæpe ciliatæ, interdum nudæ, ligula conspicua,

sublonga. *Panicula* elongata, lineari-oblonga, 4–5 poll. longa, semel bisve composita, ramis solitariis, adpressis, paucifloris, laxifloris; pedicellis spiculis brevioribus; rachi angulata, *glabra*. *Spicula* acuta, 3–5 lin. longa, glumis obsoletis. *Flosculi* neutri plerumque 3-nervii, mucronati, margine tenuiciliati, hermaphrodito glabro vix ½ breviores. *Palea* inferior nervis 7 conspicuis, acuta; superior subbrevior, binervia, bicarinata, carinis tenuiciliatis, apice bifida.

This is very close indeed to the following species, *C. Dombeyana*, and is principally to be distinguished by its extremely small, almost invisible glumes, smoother rhachis, and more glabrous leaves, with more strongly marked secondary nerves. Fendler says, "this grass spreads in many places of the primeval forest so as to exclude all other plants, and even deadens shrubs and trees, forming cane-brakes or 'carizals.'" Jameson asserts that the plant is found from the level of the sea up to 12,000 feet elevation.

19. C. Dombeyana, Kunth, Gram. ii. 553, tab. 191! Panicula elongata, angusta, ramis erecto-patulis, *laxifloris*, glumis *parvis* sed *conspicuis*; foliis angustis, subtus *pubescentibus*, "*venulis transversis obsoletis*, tamen sat crebris" (fide Ruprecht).—Enum. 428; Suppl. 350; Trin. in Act. Petrop. *l. c.* 616; Rupr. *l. c.* 123, tab. vi. fig. 22; Steud. *l. c.* 337.

Hab. Peru, *Dombey*; in Nova Granada, Bogota! Tolima! *Goudot*; Ecuador, "in sylvis ad flum. Chanchar, alt. 4000–6000 ped. s. m.," *Spruce*, no. 6093!

Culmus solidus, 9–10-pedalis, arcuatus, ramosissimus, ramis teretibus obsolete scabriusculis, ramulis floriferis subpedalibus, subdiphyllis ad nodos fasciculatim erumpentibus. *Folia* lanceolata, basi in petiolum brevem complanatum attenuata, apice acuminato-subulata, margine incrassato serrato cincta, 2–3½ poll. longa, sub 3 lin. lata, supra glabra, viridia, subtus tenuiter *pubescentia* glaucescentia, nervis secundariis 6–8 subinconspicuis ("venulis transversis hyalinis obsoletis, tamen sat crebris," fide Rupr.). *Vaginæ* sulcatæ, glabriusculæ vel inferiores hirsutæ, superne sæpe margine longe ciliatæ, ligula rotundata, brevi vel sublonga, hirsuta vel glabra. *Panicula* elongata, oblonga vel lineari-oblonga, 3½–5-pollicaris, interrrupta, ramis erecto-patulis, ramulisque abbreviatis, cum rhachi angulata vel teretiuscula *pubescenti-villosis* vel scabris. *Spicula* 2½–3 lin. longa, sessilis vel breviter pedicellata, colorata, pubescenti-hirtella, glumis *parvis sed conspicuis, obtusis* vel raro acutis, externe *pubescentibus*. *Flosculi* neutri 3–5-nervii, acutati, apice ciliati, hermaphrodito subpuberulo ⅓–½ breviores. *Palea* inferior (hermaphroditi) nervis 7–8 prominulis, superne violascens, acutata; superior brevior vel longior, quadrinervia, superne bicarinata, apice bidentata et puberula. *Squamulæ* inæquales, duæ oblique ovatæ, tertia minor ovato-elliptica. *Stylus* cito bifidus in stigmata 2 plumosa.

The preceding species may prove to be a form of this; but in *Chusquea* the length of the glumes usually affords good characters. In this species they are conspicuous, and sometimes a line and upwards long, whereas in *C. Fendleri* they may be said to be almost altogether absent.

19 bis. C. ligulata, Munro. Panicula elongata, angusta, ramis erecto-patulis, *laxifloris*; glumis inæqualibus, acutis, *superiore 2 lin. longa*; flosculo *secundo neutro* hermaphroditum *æquante*; foliis angustis, subtus *glabris*, venulis transversis *nullis*, ligula elongata.

Hab. in Nova Granada, prope Bogota, *Lindig*, no. 1125! (ex herb. Mus. Paris.); ins. Juan Fernandez? in fruticetis et sylvaticis montium editiorum, *Bertero*, no. 1431! (folia tantum). v. s.

Culmus gracilis, ramulis floriferis 9–12 poll. longis. *Folia* angusta, lineari-lanceolata, basi rotundata vel cuneata, in petiolum brevem basi subtumidum attenuata, apice setacco-acuminata, margine serrata, 3–5 poll. longa, 3–5 lin. lata, utrinque glabra, supra interdum tactu scabra, nervis secundariis 6 inconspicuis, venulis transversis nullis. *Vaginæ* sulcatæ, glabræ, margine læves, membrana infra petiolum terminatæ, *longe ligulatæ*. *Panicula* elongata, 4–5 poll. longa; ramis 1–2 poll. longis, laxis, adpressis; rhachi angulata, scabro-hispidula; spiculis plus minus longe pedicellatis. *Spicula* 5–6 *lin. longa*, fusca, scabro-hirsutiuscula; glumis *acutis*, inæqualibus, superiore 2 *lin. longa*, carinata. *Flosculi* neutri inæquales, nervoso-costati, inferior nervis 5; superior nervis 5–7, apice obtuso, hermaphroditum *involvens et æquans vel etiam superans*. *Palea* inferior flosculi fertilis neutris glabrior et minus conspicue nervosa, 7–9 nervis; superior subæquilonga, bicarinata et præterea binervia. *Squamulæ* superne fimbriatæ, subinæquales, duæ latiores. *Stylus* cito bifidus in stigmata 2 plumosa.

This species is certainly allied to the preceding in general form, habit, and appearance; but it has much longer glumes, and the spiculæ are nearly twice the length and have much longer pedicels. The second neutral flower is also unusually long and enveloping. The leaves are more glabrous, and the ligula considerably longer. The preceding pages were printed before I had an opportunity of seeing, through the kindness of M. Brongniart, a flowering specimen of this plant; and it is consequently not included in the "Conspectus Specierum" at p. 53, but should be placed between nos. 19 and 20.

20. C. ANELYTHRA, Nees in Linn. ix. 491. Panicula decomposita, ramis brevibus densifloris demum *divaricatis, glumis obsoletis*; foliis basi *subcordatis*, fere *sessilibus*, subtus dense strigosis.—Rupr. *l. c.* 120, tab. vi. fig. 16; Steudel, *l. c.* 336. *Dendragrostis anelythra*, Nees, *l. c.*

Hab. in Brasilia, *Sellow*! v. s.

Culmus lignosus, ad nodos ramosus, ramulis paucis (2–5), subpedalibus, inferne geniculato-nodosis et dense foliosis. *Folia* lanceolata, $2\frac{1}{2}$–3 poll. longa, 3–4 lin. lata, basi *subcordata*, arcte *sessilia*, stricte patentia, glaucescentia, ad petiolum barbata, subtus ad nervos dense strigosa, nervis secundariis a tertiariis ægre discernendis. *Vaginæ* tota longitudine sulcato-striatæ, pubescenti-scabræ, apice *biauriculatæ* et in ligulam obtusam productæ, efimbriatæ. *Panicula* decomposita, attenuata, pyramidalis, 5–6 poll. longa, rhachi hirsutissima, ramis pubescenti-villosis, racemosis, densifloris, demum divaricatis. *Spicula* lanceolato-acuminata, 3 lin. longa, flavescens, glabra; *glumis minimis, ad callositates redactis*. *Flosculi* neutri subæquales, inconspicue 3–5-nervati, acuti, hermaphrodito $\frac{1}{3}$ breviores. Flosculo neutro secundo interdum (teste Ruprecht in icone) bipaleaceo. *Palea* inferior (flosculi fertilis) 5 nervis, acuta, superiorem binerviam, anguste carinatam, apice bidentatam vix æquans. *Squamulæ* obovato-cuneiformes, acutæ, longe ciliatæ et *penicillato-barbatæ*. *Stylus* ad basin usque divisus, stigmatibus longis, longe plumuloso-ciliatis. "Habitus multo magis *Paniceæ* cujusdam acutifloræ ac *Chusqueæ*."—*Rupr.*

This grass has quite the habit and appearance of *Panicum proliferum*, Lam., and has a different look from all other species of *Chusquea*.

21. C. WILKESII, Munro. Panicula *vix decomposita*, ramis lævibus divaricatis tandem refractis, *axillis glandulosis*, glumis *fere obsoletis*; foliis *basi attenuatis*, subtus (basin versus) *uno latere ad costam* pilosis.

Hab. in Brasilia, Organ Montes, *Wilkes*. v. s.

Culmus scandens, fistulosus, internodiis 7 poll. longis, hirsutiusculis vel superne (infra nodos) hirsutis,

ramulis 6–8, valde inæqualibus, ad nodos fasciculatis, brevioribus (floriferis tantum) 4 poll. longis, reliquis subpedalibus, inferne foliosis, superne floriferis. *Folia* lanceolata, 3–4 poll. longa, 4–6 lin. lata, *basi attenuata*, apice setaceo-acuminata, margine serrato asperrima, supra scabra, subtus strigoso-hirsuta, punctulis minutis aspera, et basin versus uno latere ad costam pilosa (ut in *C. leptophylla*, Nees), nervis secundariis 8, vix conspicuis. *Vaginæ* inferiores hirsutæ, superiores glabrescentes, margine superne longissime fimbriatæ, infra petiolum *membrana conspicua alba* terminatæ, ligula elongata. *Panicula* vix decomposita, 2–3-pollicaris, vix (in ramulis foliiferis) e vagina suprema exserta, foliis superata, rhachi strigoso-hispida, ramis brevibus divaricatis et cito refractis, axillis glandulosis, pedicellis brevibus vel brevissimis. *Spicula* acuta, 3 lin. longa, pubescens vel hirsuta, *glumis fere obsoletis*. *Flosculi* neutri subæquales, paucinervii, ovati, mucronati, carinati, margine ciliati, hermaphrodito pubescente duplo breviores. *Palea* inferior (flosculi fertilis) mucronata, nervis 7 conspicuis, inter nervos strigoso-hispida; superior sæpissime longior, bicarinata et inter carinas hirsuta, apice bifida, bimucronata. *Stylus* cito bifidus in stigmata 2 divaricata. *Ovarium* (immaturum) subtrigonum.

This approaches *C. anelythra* in many respects, but is easily distinguished by its foliage, which is very dissimilar. The nearly obsolete glumes separate it from *C. scandens* and *C. pallida*. Nuttall, in his MS. notes on the grasses collected in Wilkes's Expedition, has marked this plant as constituting a "new genus," having apparently overlooked the very diminutive glumes.

22. C. SCANDENS, Kunth. Syn. i. 254. Panicula decomposita, *rhachi angulata scabra*, ramis brevibus divaricatis, axillis glandulosis, glumis *brevibus obtusis* vel acutis, flosculis *neutris distincte nervosis*, foliis lineari-lanceolatis, glabris.—Enum. 428 et Suppl. 350; Trin. in Act. Petrop. *l. c.* 616; Rupr. *l. c.* 123, tab. vi. fig. 21; Steud. *l. c.* 337. *C. Jamesoni*, Steud. *l. c.* 337. *Nastus chusque*, H. B. K., Nov. Gen. i. 201 (1815); Rœm. et Sch. Syst. vii. 2. 1360. *N. chusquea*, Rasp. Ann. d. Sc. Nat. v. 442. *Bambusa chusque*, Poir. Enc. Suppl. v. 494. *Mustelia arundinacea*, Cav. ined. teste Steud. Nomencl. 361.

Hab. Ecuador, Quito, "in montanis frigidis prope St. Fé de Bogota, monte Quindiu Loxæ," *Humboldt, Bonpland*; "prope Tambello," *Jameson*, no. 630!; in Nova Granada, *Linden*, 252! (e *Triana*); "in montibus juxta Bogota, *Holton*, no. 104! *Lindig*, no. 1047!; Peru?, *Jameson*. v. s.

Culmus scandens, altissimus, gracilis, internodiis asperis, ramulis dense fasciculatis, glabris, nitidis, valde inæqualibus, 4–12 poll. longis, interdum proliferis bipedalibus. *Folia* lanceolata vel lineari-lanceolata, 3–4 poll. longa, 4–5 (rarissime 9) lin. lata, in petiolum attenuata, angustato-subulata, margine lævi vel vix serrato, membranacea, glabra vel subtus pilis paucis sparsis vix pilosa, supra viridia, subtus pallidiora, nervis secundariis 6–8 conspicuis. *Vaginæ* glabræ, infra petiolum membrana elongata sæpe ciliata terminatæ, ligula brevi vel plus minus elongata (nulla, teste Kunth). *Panicula* decomposita, sub-3-pollicaris, plerumque longe exserta, ramulis patentibus cito divaricatis, subsecundis, abbreviatis, sæpe densifloris, axillis glandulosis, rhachi angulato-scabra, pedicellis brevibus. *Spicula* (sæpe pulchre variegata) lanceolato-cylindracea, 2–3 lin. longa, acuminato-subulata, glabra vel pubescens, glumis parvis, obtusis vel superiore longiore acuta. *Flosculi* neutri *distincte nervosi*, ovati, apice subulati, colorati vel pallidi; superior hermaphrodito parum brevior. *Palea* inferior (flosculi fertilis) multinervia, mucronato-subulata (basi eximie lutescens, fide Rupr.); superior binervia, apice bifida, laciniis subulatis. *Stylus* cito bifidus. *Squamulæ* inæquales, ovato-oblongæ, membranaceæ, glabræ.

This appears to be a long, slender, decidedly climbing plant. The branchlets occa-

sionally become very compound, and are upwards of 2 feet in length; the panicles then are very long, peduncled, and the leaves are longer; and this is the form seen in no. 252 of Triana.

23. C. PALLIDA, Munro. Panicula decomposita, rhachi *pilis longis hirsuta*, ramis brevibus, primum adpressis demum divaricatis, glumis *brevibus obtusis*, flosculis neutris fere *enervibus*, foliis fere ovato-lanceolatis vel lanceolatis, *glabris*.

Hab. in Nova Granada; Sta. Martha! *Purdie*; Venezuela, "inter Caracas et La Guayra," alt. 1500 ped. s. m., *Fendler*, no. 1625! (folia tantum). v. s.

Culmus elatus, solidus, internodiis validis lævissimis, spathis glabris apice foliaceis involutis, ramulis numerosis subpedalibus fasciculatis, ramorum nodis pilis (sæpe longis et refractis) hirsutis. *Folia*, in ramulis floriferis, fere ovato-lanceolata, in foliiferis lanceolata, 3–5 poll. longa, 4–9 lin. lata, basi vix attenuata, apice setaceo-acuminata, margine aspera, membranacea, concoloria, supra tactu scabra, subtus glabra vel sub lente strigosa, nervis secundariis 8 conspicuis. *Vaginæ* glabrescentes, maculatæ, striatæ, margine ciliatæ (ciliis interdum basi bulbosis, supremis longis refractis), infra petiolum membrana chartacea terminatæ, ligulatæ. *Panicula* decomposita, 3–6 poll. longa, rhachi pilis longis hirsuta, ramulis mox patentibus, brevibus, spiculis brevipedicellatis. *Spicula pallida*, hyalina, 5 lin. longa, subpubescens, mucronato-acuminata, glumis 2 minimis obtusiusculis. *Flosculi* neutri membranacei, glaberrimi, vel uninerves, vel enerves, mucronati, *apicibus sæpe divergentibus*, hermaphrodito fere duplo breviores. *Palea* inferior (flosculi fertilis) nervis 7–9 conspicuis, glaber vel nervorum interstitiis pubescens, mucrone brevi scabro subulata, dorso sæpe cito fissa; superior brevior, leniter nervosa, carinata, breviter bifida.

This approaches *C. scandens* very closely, but appears to be distinguished by its broader leaves, much more hairy rhachis, larger, paler-coloured, and transparent spicula, and shorter nerveless neutral flowers.

24. C. MULLERI, Munro. Panicula decomposita patente, ramis *elongatis*, *rhachi fere glabra*, spiculis $4\frac{1}{2}$ lin. longis, glumis *mucronatis inæqualibus*, superiore duplo longiore, foliis lato-lanceolatis, *utrinque glabris*, nervis secundariis subtus inconspicuis.

Hab. in Mexico, Vera Cruz, Orizaba, *Muller*, no. 2024! v. s.

Culmi pars superior (abnormalis, sesquipedalis) tantum adest. *Folia* glaucescentia, *lato-lanceolata*, 4–5 poll. longa, 4–6 lin. lata, basi attenuata, apice acuminata, margine serrata, glabra, subtus pallidiora, striata, nervis secundariis inconspicuis. *Vaginæ* glabræ sed margine longe ciliatæ, ligula elongata, hirsuta. *Panicula* (juvenilis) aperta, decomposita, radiis paucis solitariis, rhachi pedicellisque (spiculis fere dimidio brevioribus) *glabris*. *Spicula* glabra, 4–5 lin. longa, glumis inæqualibus, inferiore acuto-mucronata vel tridentata, superiore duplo longiore mucronata. *Flosculi* neutri glabri, colorati, trinerves, apice attenuati, hermaphrodito distincte nervoso, glabro, acuminato fere $\frac{1}{3}$ breviores. *Palea* superior (flosculi fertilis) glabra, canaliculata.

I have only seen one specimen of this, sent by Dr. Meisner to the Kew Herbarium, evidently composed of two proliferous branchlets. I have no doubt, however, that it is a good species. It approaches *C. scandens* in some respects.

25. C. QUILA, Kth. Gram. i. 138, 329, t. 77. Panicula decomposita, ramis demum elongatis, cito patulis et divaricatis, *rhachi hirsuta*, spiculis 2–3 lin. longis, glumis *cuspi-*

datis subæqualibus, flosculis neutris $\frac{1}{3}$–$\frac{1}{2}$ brevioribus, foliis lanceolatis, subtus *puberulis* vel *pubescentibus* venulis transversis plus minus conspicuis.—Enum. 428; Suppl. 351; Trin. in Act. Petrop. *l. c.* 616; Rupr. *l. c.* 123, tab. ix. fig. 20; Steud. Syn. 336. *C. pubescens*, Steud. *l. c.* 337. *C. Valdiviensis*, Em. Desv. in Gay, Fl. Chil. vi. 446; Walp. Ann. vi. 1044. *C. intermedia*, Steud. in Lech. Fl. Chilensis (nomen tantum). *Arundo quila*, Poir. Enc. vi. 274; Rœm. et Sch. Syst. Veg. Mant. ii. 479. An etiam *A. quila*, Molina, Geog. Nat. and Civil Hist. of Chili, i. 126 (1809)? *Nastus quila*, Rœm. et Sch. Syst. vii. 2. 1361.

Hab. in Chili, *Dombey*; Valparaiso, *Capt. King*! *Wilkes*!; Valdivia, *Bridges*, 821! *Philippi*! *Lechler*, 525! & 525 *a*!; ins. Chiloe, *Capt. King*! *Anderson*! v. s.

Culmus ramosissimus, elatus, internodiis sæpe 9 poll. longis, farctis, lævigatis vel apice scabris; ramulis floriferis patulis, 6–15 poll. longis, subcompressis, vel 4–5-phyllis vel polyphyllis, ad nodos fasciculatis. *Folia* herbacea, lanceolata vel lineari-lanceolata, 2–4–6 poll. longa, 3–4–7 lin. lata, basi cuneata, interdum inæquilatera, apice acutato-subulata, margine cartilagineo remote spinuloso, supra glabra, subtus glaucescentia, puberula vel pubescentia, pilis longis sæpe inspersis, nervo centrali prominulo, secundariis 6–10, venulis transversis subinconspicuis vel in var. *Valdiviensi* conspicuis pellucidis. *Vaginæ* glabræ, apice pilosiusculæ, margine ciliatæ, infra petiolum membrana brevi ciliata terminatæ, ligula ciliato-pilosa. *Panicula* 2–6 poll. et ultra longa (pedalis teste Steud. ad *C. pubescens*), rhachi angulata, pubescente vel hirsuta, ramis cito patulis, sæpe densifloris, inferioribus interdum $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, pedicellis brevibus. *Spicula* ovata, 2–3 lin. longa, pallida vel colorata, subnitida vel puberula, glumis cuspidatis subæqualibus, flosculis neutris $\frac{1}{3}$–$\frac{1}{2}$ brevioribus. *Flosculi* neutri subæquales, 3–5-nerves, cuspidati, sæpe discolores, hermaphrodito glabro vel pilis brevibus adpressis hirto $\frac{1}{3}$–$\frac{1}{2}$ breviores. *Palea* inferior (flosculi fertilis) nervis 7 distinctis, acuto-mucronata; superior brevior vel longior, 4–6-nervis, apicem versus subbicarinata, apice emarginata. *Squamulæ* hyalinæ, inferne 4–5-nerves, apice obtusæ et piliferæ. *Stylus* cito bifidus in stigmata 2 plumosa. *Fructus* immaturus lineari-oblongus, glaber vel puberulus (teste Steudel).

I have fortunately had numerous specimens of this plant to examine, and feel, after careful comparison, that I am justified in considering all the species named above to be either identical with or mere varieties of the original *C. quila*. Kunth's drawing represents an unusual state, with the panicle shorter and less compound than it generally is. Lechler's no. 525 contains a specimen of this state. *C. Valdiviensis*, which has the transverse veinlets more conspicuous and the spiculæ more hirsute than usual, has, I think, been created by a misapprehension of Philippi's as to what the true *C. quila* is; for in Linnæa, xxix. 103, he says that "in *C. quila* glumæ aristatæ sunt, spiculam subæquantes." I do not know what his authority is for this statement, which certainly does not coincide with Kunth's description or figure. I must refer to this again in describing the following species. This plant is stated by various collectors to be called by the inhabitants "Quila," "Kili," or "Keelee."

26. C. TENUIFLORA, Philippi in Linnæa, xxx. 206. Panicula decomposita, elongata, gracili, ramis demum divaricatis, rhachi *scabro-hirsuta*, glumis *longis spiculam æquantibus vel superantibus*, foliis angustis subtus *glabris* vel *puberulis*.—*C. quila*, Em. Desv. *l. c.* 447 (non aliorum)? *C. ciliata*, Philip. *l. c.* xxxiii. 299?

Hab. in Chili, Valdivia, San José in nemoribus, Santiago in maritimis, *Philippi*!; Chiloe, *Germain*. v. s.

Culmus ramosissimus, 6–12-pedalis, internodiis 5 poll. longis, fere glabris; spathis sub 3 poll. longis, striatis, glabris; ramulis tenuibus, plerumque 7–9 poll. longis, interdum sesquipedalibus, sub-4-phyllis, fasciculatis. *Folia* herbacea, lineari-lanceolata, 2–4 poll. longa, 3–4–5½ lin. lata, basi attenuata, inæqualia, apice sensim acuminata, margine valde serrato, subtus glabra vel pilosa, nervis secundariis duobus in uno latere, tribus in altero, costa parum prominente, venulis transversis vix conspicuis, pellucidis. *Vaginæ* superne fere glabræ, inferne hirsutiusculæ, margine subhirsutæ vel longe fimbriatæ, ligula producta. *Panicula* 6–8 poll. longa, angusta, rhachi scabro-hirsuta; radiis principalibus elongatis, primum adpressis, demum divaricatis, interdum laxifloris; pedicellis hirsutis, brevissimis. *Spicula* ovata, 3 lin. longa, pallida, sub lente strigoso-hispida, glumis subtrinervibus, setaceo-acuminatis, spiculam æquantibus. *Flosculi* neutri lanceolati, cuspidati, glumis breviores, subtrinerves, hermaphroditum vix æquantes. *Palea* inferior (flosculi fertilis) oblonga, mucronata, superne 5–7-nervis, interdum margine ciliata; superior brevior, binervis, subobtusa. *Squamulæ* oblongæ, obtusæ, apice pilis paucis fimbriatæ, fere enervosæ. *Stylus* basi simplex, tunc divisus in stigmata 2 gracillima pulchre plumosa.

I imagine this to be the plant which was considered by Em. Desvaux and Philippi to be the true *C. quila*, and that this misapprehension, already referred to, induced them to describe *C. Valdiviensis* and perhaps *C. ciliata* as new species. I believe that *C. tenuiflora* is a young state, and *C. ciliata* a more advanced state of the same plant. In one of the specimens, of what I believe to be this species, in Herb. Kew. (sent from Chili by Philippi, but without a name), the branches are nearly 2 feet, and the panicle 7–8 inches long; and altogether the plant appears to have a habit of growth very different from that of the other allied species.

Sect. II. "Panicula contracta, subrotunda (raro ovalis), capitulum referens. Folia superiora interdum basin capituli arcte involucrantia." *Rettbergia*, Raddi et Nees.

27. C. Sellovii, Rupr. *l. c.* 125, tab. ix. fig. 26. "Capitulis terminalibus suborbiculatis, rhachi pedicellisque *dense pilosis*, glumis *minutis obtusis pilosiusculis*, foliis lanceolatis concoloribus."—Steud. *l. c.* 337.

Hab. in Brasilia, *Sellow*. s. v. Ruprecht.

"*Culmus* farctus, *tenuissimus, filiformis*, debilis, scandens, ramulis ad nodos subternis, 2–3-pollicaribus, diphyllis, inferne capitulo brevipedunculato, aphyllo, recurvato plerumque auctis. *Folia* lanceolata, concoloria, chartacea, 2 poll. longa, 4 lin. lata, basi apiceque attenuata, margine setulis paucis, remotis, longioribus, demum deciduis obsita, venulis transversis, subtus sæpe anastomosim perfectam exhibentibus, nervis secundariis 2 subobsoletis. *Capitulum* suborbiculatum, diametro 7-lineali, rhachi pedicellisque dense pilosis. *Spicula* 2 lin. longa, *maculata*, glumis minutis, pilosiusculis, *obtusis*, flosculo infimo chartaceo, obsolete striato 3–4-plo brevioribus; flosculo secundo opaco, scabro, chartaceo, hermaphrodito obtuso distincte breviore. *Palea* superior (flosculi fertilis) multinervia, dorso canaliculata, obtusa. *Stylus* cito bifidus in stigmata 2 pilosa."—*Rupr.* desc. et icon.

28. C. Gaudichaudii, Kunth, Rev. Gram. i. 138, 331, t. 78. "Panicula ovato-oblonga, rhachi *glabra*, glumis *acutis brevibus*, paleis obtusiusculis, foliis ovato-lanceolatis."—Enum. 428, Supl. 352; Rupr. *l. c.* 124, tab. ix. fig. 24; Steud. *l. c.* 337. *Rettbergia bambusæoides*, Raddi, Agros. Bras. 17, t. i. fig. 1 (analysis spiculæ tantum); Nees in Agros. Bras. 536.

Hab. in Brasilia, Rio de Janeiro, Corcovado Mont., *Raddi, Gaudichaud, Mertens.* s. v. Ruprecht et Kunth.

"*Culmus* altissimus, ramosus, scandens ?, ramulis ad nodos subternis, subpedalibus (1½ lin. latis), pleio-(9) phyllis. *Folia* ovato-lanceolata (Kunth), lineari-lanceolata (Rupr.), 3–3½ poll. (teste Kth.), 6–8 poll. (teste Rupr.) longa, utrinque glabra, subtus pallidiora, basi inæqualia, cuneata, apice angustato-acutata, nervis secundariis 9, venulis transversis rarissime vel non anastomosim plenam referentibus. *Vaginæ* compressæ, carinatæ, superne ciliatæ, ligula prominente, oblique rotundata, glabra. *Panicula* patens, ovato-oblonga, bipollicaris, *rhachi glabra*. *Spicula* (interdum monoica, teste Raddi) oblonga, pedicellata, castaneo-fusca, coriacea, nitida, 4–5 lin. longa, glumis acuminatis, brevibus, 1–1½ lin. longis, carina scabris. *Flosculi* neutri obtusiusculi, glabriusculi, obsolete 7-nervii, inæquales, superior hermaphrodito parum brevior. *Palea* inferior (flosculi fertilis) flosculis neutris simillima, sed major; superior subæquilonga, ad dorsum superne sulco hirtello notata, 6-nervia. *Squamulæ* angustæ, integræ, apice pilis longis ciliatæ, inæquales, duæ trinerviæ, tertia brevior 1-nervia. *Stylus* cito bifidus in stigmata 2 pilosa (Rupr.), unilateralia, intus plumosa (Kunth)."—*Ruprecht et Kunth*, descr. et icon.

I am only acquainted with this plant from Kunth's drawing, and Ruprecht's and Kunth's descriptions. Nees says he never saw the plant, and, quoting Raddi's words verbatim, states that he cannot but doubt the correctness of them. Judging from Kunth's drawing, I cannot consider that the plant should be placed in the section defined by having "panicula contracta capitulum referens." It appears to me that it should have been placed next to *C. oligophylla*, to which it is evidently closely allied. It will be observed that the two descriptions by Kunth and Ruprecht differ in many respects, especially as to the size and form of the leaves. Kunth states that he described and figured his plant from a specimen sent by Gaudichaud. Ruprecht does not state from what particular specimen his description was made.

29. C. CAPITULIFLORA, Trin. Act. Petrop. *l. c.* 613, icon. 339. "Capitulis terminalibus, *rhachi pedicellisque* dense *pubescentibus*, glumis *acuminato-subulatis*, carinis ciliatis, paleis *nervosis* subobtusis, foliis ovato-lanceolatis."—Rupr. *l. c.* 125, tab. ix. fig. 25; Steudel, *l. c.* 337.

Hab. in Brasilia, Rio Janeiro in sylvis umbrosis ("Quixiume" incolis), *Riedel.* s. v. Trinius et Ruprecht.

"*Culmus* altissime scandens, crassitie 1-lineali, teres, ramulis ternis vel numerosis, fasciculatis, spithamæis, folii (5)-geris, patentibus, imo quandoque declinatis. *Folia* ovato-lanceolata (maxima 3 poll. longa, et 5 lin. lata), viridia, concoloria, basi apiceque attenuata, venulis transversis (subtus) raro anastomosim perfectam exhibentibus. *Vaginæ* glabræ, ligulæ loco margine subauriculato-productiusculo. *Capitulum* suborbiculatum, diametro 8-lineali, folio supremo parvo stipatum, rhachi pedicellisque dense pubescentibus. *Spicula* ovato-oblonga, 3–4-linealis, plus minus obtusa, glumis *acuminato-subulatis*, nervosis, scabriusculis, ad carinam ciliatis, flosculo infimo duplo brevioribus. *Flosculi* neutri inæquales, 7–9-nervii, nervoso-striati, glabri, obtusi, interdum minutissime mucronulati, inferior paulo vel ¼ brevior; secundus hermaphroditum obsolete nervosum, nitidum, coriaceum, obtusum æquans vel parum superans. Rarissime accedit *flosculus neuter tertius*, vel etiam spiculis alteris flosculi 2 hermaphroditi occurrunt. *Palea* superior inferiore paulo brevior, bicostata, et præterea utrinque binervis. *Squamulæ* 3, subæquales, inferne nervatæ, superne fimbriatæ. *Stylus* ad basin bifidus in stigmata 2 pubescenti-plumosula."—*Trinius et Ruprecht.*

30. C. CAPITATA, Nees in Linnæa, ix. 489. Capitulis terminalibus densissimis, rhachi pedicellisque *puberulis*, glumis *setaceis*, *longis*, *spiculam* æquantibus; foliis lanceolatis, basi rotundatis.—Rupr. *l. c.* 125, tab. viii.; Steud. *l. c.* 338. *Rettbergia capitata*, Nees, *l. c.*

Hab. in Brasilia, *Sellow*! *Lhotsky*. v. s.

Culmus scandens, rigidus, crassitie lineali, ramulis creberrimis e nodis fasciculatim erumpentibus, spithamæis, aliis sterilibus 3–4-phyllis, aliis subaphyllis, aliis foliiferis floriferisque. *Folia* ovato-lanceolata 3–4½ poll. longa, 3–6 lin. lata, glabra, basi rotundata, nervis secundariis 6–8 subtus parum conspicuis, "venulis transversis anastomosim dimidiam exhibentibus." *Vaginæ* glabræ, ligula brevi rotundata. *Capitulum* suborbiculare, 6–10-lineale, ad basin foliolis 2 suffultum, rhachi pedicellisque striato-sulcatis puberulis. *Spiculæ* 3–4 lin. longæ, compressæ, carinatæ, ovatæ, flavido-stramineæ, fasciculis parvis, ad rhachim communem dense et subsecundo dispositæ, imbricatæ, glumis setaceis flosculos omnes æquilongos attingentibus. *Flosculi* neutri basi nervosi, acuti, subpubescentes. *Hermaphroditi* palea inferior 5-nervis, apice subobtuso mucronulata; superior apice bifida, æquilonga. *Squamulæ* valde inæquales, efimbriatæ (teste Rupr. in icone).

CHUSQUEÆ *cognitæ steriles* (*foliiferæ tantum*) *igiturque dubiæ.*

31. C. LEPTOPHYLLA, Nees in Linn. ix. 489. Foliis linearibus, elongatis, acuminatis, basi inæquilatero-cuneatis, 5-nervosis, glaucis, subtus basin versus *uno latere pilis longis hirsutis*.—Rupr. *l. c.* 119, et Steud. *l. c.* 336, sub *Arthrostylidium Trinii*.

Hab. in Brasilia, *Sellow*. v. s. absque floribus.

Culmus crassitie pennæ cygneæ, ramulis numerosis, 6–18 poll. longis, glabris, filiformibus, e nodis compressiusculis et scrobiculato-punctatis erumpentibus. *Folia* angustissima, 1½–5 poll. longa, vix 2 lin. lata, basi attenuata, inæquilatera, apice setaceo-acuminata, margine supero ciliata, glauca, nervis secundariis utroque latere 2–3, subtus, ad basin, petiolum versus, *uno latere dense pilosa*. *Vaginæ* glabræ, striatæ, ore bilobæ ciliatæque, ligula *nulla*.

I have already stated, at p. 45, that Ruprecht and Steudel thought it probable that this plant might be a sterile state of *Arthrostylidium Trinii*, but that I did not coincide with them. The specimens that I have seen bear a general resemblance to several species of *Chusquea*, especially to *C. Dombeyana*. In *C. Wilkesii* the leaves, which are 4–6 lines broad, are hairy below on one side only; and the same one-sided pubescence is found occasionally in the narrow-leaved Guaduas. Nees does not mention this pubescence on the lower surface of the leaves, but says that they are fringed on one margin and smooth on the other.

32. C. HETEROPHYLLA, Nees in Linn. ix. 488. "Culmo *tetragono* pubescenti-scabro, foliis aliis *lanceolato-linearibus*, aliis *ovato-acuminatis*, acutissimis, sessilibus, supra scabris, *subtus* glaucis, *glabris*."—Rupr. *l. c.* 122 (in not. ad *C. pinifolia*); Steud. *l. c.* 336.

Hab. in Brasilia, *Sellow*. s. v. Nees et Ruprecht.

"*Culmus* obtuse tetragonus, scaber, infra nodos fusco hirto-tomentosus et nigro maculatus (ut in *C. pinifolia*), ramulis e nodis dense fasciculatis, patulis. *Folia* lanceolato-linearia, acutissima, sessilia, supra

scabra, subtus glauca, glabra, parum transparentia, nervis secundariis a tertiariis non discernendis, mox convoluta, diutius persistentia, inferiora ramulorum propullantium *ovato-acuminata*, imbricata, 6–7 lin. longa et 2 lin. lata. *Vaginæ* striatæ, scabræ, sursum versus subpuberulæ."—*Nees et Ruprecht.*

This plant, as described, is evidently in an abnormal condition; and I think it is very probable that Ruprecht is correct in considering that it may be a state of *C. pinifolia*, with some of the leaves very much broader than usual. Nees, however, considers that it is more nearly allied to *C. Cumingii*.

C. AMPLOPANICULATA, Steud. Syn. 337; Miq. Fl. Ind. Bat. iii. 414=*Dinochloa Tjankorreh*, Busè.

C. FIMBRIATA, Steud. *l. c.* 338=*Merostachys capitata*, Hook.

VIII. PLANOTIA.

Munro. *Platonia*, Kunth, Gram. i. 139, 327, t. 76! (sed non Martii). *Chusqueæ*, subgen. *Platonia*, Nees in Linn. ix. 486; Endl. Gen. Plantarum, no. 906.

Spicula deorsum imperfecta, 3-flora, intra glumas sessilis vel brevissime pedicellata, *rhachilla obsoleta* vel subinconspicua, flosculis 2 inferioribus neutris 1-paleaceis, *terminali bipaleaceo, hermaphrodito* simillimis. *Glumæ* 2, plerumque breves, in *P. acuminatissima* longissimæ. *Flosculi* neutri acuti vel obtusi. *Palea* inferior flosculi fertilis coriacea, paucinervis, acuta aut obtusa, nunc divergens, nunc superiorem, sæpe obtusam et dorso convexam, obsolete binervem, involvens. *Stamina* 3. *Squamulæ* 3, membranaceæ, vel multinerves obtusissimæ, vel paucinerves lanceolato-acuminatæ. *Stylus* plerumque cito fere ad basin bifidus, stigmatibus basi nudis, superne plumosis, divergentibus. *Caryopsis* vel ovalis vel ovato-oblonga et rostrata.

Gramina *herbacea* in Nova Granada, Quito et ins. Trinidad, in montibus excelsis crescentia. *Culmus* subenodosus, simplex, 6–10-pedalis. *Folia* basi inarticulata et valde attenuata, forsan omnium graminum maxima, 2–15 ped. longa, 3–12 poll. lata. *Vaginæ* sæpe ore *biappendiculatæ*. *Inflorescentia* panicula thyrsoidea vel decomposita, patula vel contracta, folia superans, pedicellis plerumque brevibus, in *P. aperta* longissimis.

Many of the preceding pages had been printed before I observed that the same word, *Platonia*, had been adopted by three different authors for three very different genera; and the question of priority then arose. *Platonia* of Rafinesque, probably the first in point of date, is absorbed in *Lippia*, Linn. (Verbenaceæ). *Platonia*, Martius, Nov. Gen. et Sp., published in the same year (1829) as Kunth's genus of Gramineæ, has been retained as a genus of Guttiferæ at p. 174 of Bentham and Hooker's 'Genera Plantarum;' and it is therefore certainly desirable that a new name should be adopted for Kunth's genus. I have accordingly altered the word as little as possible, and adopted an anagram, *Planotia*, containing the same letters. Widely different opinions are entertained about this genus by different authors. Nees, Endlicher, and others have considered it a section of *Chusquea*. Ruprecht, at p. 120 of the monograph so constantly referred to, says, "*Platonia* vero natura sua valde a *Chusquea* distat," and does not include it amongst the Bamboos. Grisebach says, "*Platonia* is less related to *Chusquea* than to *Uniola*, and more distantly to *Phalaris*." In my opinion *Planotia* must be placed next

to *Chusquea*, from which, as far as the structure and details of the spicula are concerned, it can scarcely be distinguished, although in inflorescence and foliage the two genera are widely apart; and I have already, at pp. 52 and 53, stated in what respects these two genera differ from all other grasses.

Conspectus Specierum.

Panicula plus minus densa, pedicellis *brevibus*.

Glumæ breves, *subrotundo-ovatæ*, mucronatæ. Flosculi neutri *acuti*.

Palea inferior superiorem involvens. Folia 9–10 lin. lata . . . 1. *P. elata*.

Glumæ lanceolatæ; superior longa. Flosculi neutri mucronati. Palea inferior *divergens*. Folia supra medium 2 poll. lata . . . . 2. *P. virgata*.

Glumæ breves, subhirsutæ. Flosculi neutri *obtusi*. Folia 3–12 poll. lata 3. *P. nobilis*.

Glumæ *longissimæ*, spiculam duplo et ultra superantes . . . . 4. *P. acuminatissima*.

Panicula laxa, aperta, pedicellis *longissimis* . . . . . 5. *P. aperta*.

1. P. ELATA, Munro. "Panicula 13–14-pollicari, ramosissima, contracta, ramis fasciculatis approximatis, rhachi angulata hispido-scabra, glumis *parvis*, *subrotundo-ovatis*, acuminatis, foliis 9–10 lineas latis, vaginis hirtellis demum glabris."—*Platonia elata*, Kunth, Gram. i. 139, 327, t. 76! Enum. 429; Suppl. 353; Steud. *l. c.* 338.

Hab. in Quito, "Loxa in frigidis," *Humboldt, Bonpland* (3351). s. v. Kunth.

"*Culmus* erectus, 4–5-pedalis (Kunth), 12–18-pedalis (Bonpl.), simplex, teres, sulcato-striatus, glaber, basi foliosus. *Folia* longissima, culmo parum breviora, lanceolato-linearia, apice angustato-acutata, plana, inferiora angustiora et canaliculata, *cum vagina continua*, striato-nervosa, nervo medio crasso subtus prominente, coriacea, glabra, margine obsoletissime serrulato-scabra, 9–10 lineas lata. *Vaginæ* sulcatæ, hirtellæ, tardius glabræ, ligula ovata, obtusa, glabra. *Panicula* elongata, 13–14-pollicaris, ramosissima, contracta, ramis fasciculatis, approximatis, brevibus, adpressis, rhachique angulata hispido-scabris; spiculis vix 2 lin. longis, ovato-ellipticis, pedicellatis. *Glumæ* parvæ, subrotundo-ovatæ, acuminatæ, fuscescentes, nitidulæ, glabræ; inferior brevior, subcarinata. *Flosculi* neutri ovato-elliptici, acuti, obsolete trinervii, læves, glabri, flosculo fertili breviores. *Palea* inferior (flosculi fertilis) coriacea, glabra, subrotundo-ovato-acuta, obsolete nervosa, superiorem obsolete binerviam, apice bilobam vix superans. *Squamulæ* 3, subrotundæ, ciliatæ, glabræ, inferne *multinerviæ*. *Styli* 2, terminales, breves, recurvati, stigmatibus subplumosis. *Ovarium* (immaturum) cylindraceo-oblongum, subarcuatum."—"Descrip. secundum specimen Humboldt." (*Kunth.*)

This plant, as represented by Kunth in his fine drawing, has very much the general appearance of a large *Eragrostis*, and is extremely like *P. acuminatissima*, which, however, is well distinguished by its long glumes.

2. P. VIRGATA, Munro. Panicula pedali, rigida, ramis supremis densissime imbricatis, inferioribus erecto-patulis, rhachi dense pubescente, glumis *lanceolatis*, acutis, *superiore flosculum infimum æquante*, foliis supra medium 2 poll. et ultra latis, vaginis glabris.—*Platonia virgata*, Grisebach, *l. c.* 530.

Hab. in Trinidad, Tocuche, *Dr. Crueger*! v. s.

Culmus basi foliosus, glaber, cylindricus, 6-pedalis, diametro 2 lin. *Folia* lanceolata, breviter mucronata, margine serrato-scabra, 2–2½ ped. longa, supra medium 2 poll. lata, basi longe attenuata, utrinque

glabra, sed supra tactu scabra, nervis secundariis a tertiariis non discernendis, venulis transversis distantibus, sat conspicuis. *Vaginæ* glabræ, ore ciliatæ et biappendiculatæ. *Panicula* elongata, 12–14-pollicaris, attenuata, superne densissima, ramis inferioribus subpollicaribus, distantibus, erecto-patulis, rhachi angulata, sulcata, pilis sublongis dense pubescente, spiculis brevi-pedicellatis. *Spicula* 2½ lin. longa, intra glumas brevissime pedicellata, fusca, nitida, glumis lanceolatis, uninervibus, acutis, inæqualibus, superiore flosculum infimum neutrum subæquante. *Flosculi* neutri patuli, dorso nitido-glabri, margine hirsuti et fimbriati, subenerves, fere spinoso-mucronati, superior hermaphroditum subæquans. *Palea* inferior (flosculi fertilis) patula, obsolete trinervis, apice mucronato-acuta, superne hirsuta, superiorem coriaceam, obtusam, dorso convexam, subhirsutam paulo superans. *Stamina* 3. *Squamulæ* 3, inæquales, tertia multo minor, obtusissimæ, multinerves, apice tenuiter, fimbriatæ. *Stylus* fere ad basin divisus, stigmatibus basi nudis, superne plumosis, divergentibus. *Ovarium* (immaturum) ovali-oblongum, birostratum.

This approaches *P. elata* very closely, principally differing in the size of the leaves and the divergent lower palea. In general form and habit it bears a most striking resemblance to *Leptochloa Wightiana* of Nees.

3. P. NOBILIS, Munro. Panicula decomposita, maxima, 4-pedali et ultra, ramis decompositis, glumis *brevibus hirsutiusculis*, flosculis *neutris obtusis*; foliis basi inarticulatis, *maximis* interdum 15 *ped. longis* et 3–12 *poll. latis.*

Hab. in Nova Granada, Paramo de Rinz ("Sorbitana" incolis), *Purdie*! v. s.

Culmus erectus, simplex?, basi foliatus, fistulosus. *Folia*, forsan omnium graminum maxima, 5–15 ped. longa, 3–12 poll. lata, multistriata, subglabra vel margine scabra, basi attenuata, vaginantia, inarticulata (an semper?). *Panicula* (pars suprema 4-pedalis tantum visa) maxima, decomposita, rhachi angulata, sulcata, hirsuta, ramis 5–9 poll. longis, decompositis; pedicellis hirsutis, brevibus vel sæpe subobsoletis. *Spicula* 1½ lin. longa, nitida, glumisu ninervibus, brevibus, hirsutiusculis. *Flosculi* neutri *obtusi*, subæquales, nitidi, margine tenuissime ciliati, inconspicue nervosi, hermaphrodito subglabro, apice tantum hirsutiusculo duplo breviores. *Flos* fertilis apertus, obtusus, paleis æqualibus. *Squamulæ* 3, obtusissimæ, multinervosæ, superne margine tenuiciliatæ. *Stylus* cito bifidus, stigmatibus recurvatis. *Ovarium* exacte ovale.

This appears to have the largest leaves of any grass known. Purdie says, "This noble and beautiful grass forms quite a feature in the scenery of the highest wooded mountains of the Paramo of Rinz; and the leaves, often attaining a foot in diameter and 15 feet in length, are valuable for making huts."

4. P. ACUMINATISSIMA, Munro. Panicula thyrsoidea, apice spicata, basi composita' sesquipedali, glumis acuminatissimis, *paleas longe superantibus*, foliis sub 2 ped. longis hirsutis.

Hab. in Nova Granada, Tolima, *Goudot*! *Linden* (*Triana*) 50! v. s.

Culmus erectus, simplex, basi foliatus, (panicula inclusa) 6-pedalis. *Folia* longa, 2-pedalia et ultra, 6–12 lin. lata, striata, hirsuta. *Vaginæ* longissimæ, striatæ, hirsutæ. *Panicula* 1½-pedalis, apice fere spicata, medio et basi composita, ramis inferioribus 3–4 poll. longis, adpressis, rhachi angulata, sulcata, pilis longis sparsis hirsuta; pedicellis brevissimis, hirsutis, sæpe glandulosis. *Spicula* (sine glumis) vix lineam longa, ovata, subhirsuta; glumis longissimis, 1-nervibus, setis scabris, acuminatissimis, flosculis duplo triplove longioribus. *Flosculi* neutri subæquales, acuminati, inconspicue venosi, nitidi, apice scabriusculi, hermaphroditum glabrum, fere membranaceum plerumque supe-

rantes. *Squamulæ* 3, basi latæ, apice conico-acuminatæ, fere enervosæ, margine superiore tenuiciliatæ. *Stylus* basi, brevi spatio, simplex, tunc bifidus.

This fine species is well distinguished by its very long glumes, rivalling in that respect *Chusquea aristata*, Munro, which it resembles in many respects, although of course widely separated from it by the character of its foliage.

5. P. APERTA, Munro. Panicula pedali et ultra, *aperta*, *patula*, rhachi *glaberrima*, pedicellis *longis*; spiculis *obtusis*, sub-3-linealibus; foliis $1\frac{1}{2}$–$2\frac{1}{2}$ ped. longis, subtus *pubescentibus*.

Hab. in Nova Granada, sub nom. "Chusquea de Paramo," *Goudot*! v. s.

Culmus erectus, simplex? (folia 2 et panicula tantum visa). *Folia* $1\frac{1}{2}$–$2\frac{1}{2}$ ped. longa, 1 poll. lata, supra glabra, subtus pubescentia et glaucescentia, basin versus, miro modo, in petiolum 3–4 *poll. longum* attenuata, inarticulata. *Vaginæ* præcipue apicem versus hirsutæ, utroque latere *processu* 2 *poll. longo auriculatæ*. *Panicula* 16 poll. longa, amplissima, laxa, rhachi glaberrima, radiis primariis subsolitariis, sæpe dichotomis, pedicellis interdum longissimis (1 poll. et ultra). *Spicula* sub 3 lin. longa, subobtusa, glabra, glumis brevibus vel brevissimis, ovatis, obtusis, enerviis, fimbriatis, flosculis neutris plus quam duplo brevioribus. Hi *flosculi* obtusi, inconspicue nervosi, margine vix fimbriati, concolores, hermaphroditum simillimum, subobtusum, glabrum, membranaceum fere æquantes. *Squamulæ* 3, multinerviæ, membranaceæ. *Stylus* cito bifidus in stigmata 2 valde divergentia. *Ovarium* apice brevirostratum.

A very fine grass, unlike any other of the genus, with most remarkably long-petioled leaves, and very curious appendages or auricles to the vagina.

Fendler, no. 2501!, from Colonia Tovar, in Venezuela, is probably another species of *Planotia*. I have, however, only seen some leaves of this, which are 6 feet long and 5 inches broad, with unusually long ligules. Fendler states that it had never been seen in flower or fruit.

Section II. BAMBUSEÆ VERÆ (conf. supra, p. 12).

Conspectus Generum.

Glumæ *nunquam* gemmiparæ. Stamina 6, filamentis basi liberis. Squamulæ 3, normales. Styli 3, fere ad basin discreti. Spiculæ 5–7-floræ, flosculo (*nonnisi penultimo*) *bipaleaceo*, hermaphrodito	9. *Nastus*.
Glumæ *plerumque* gemmiparæ. Stamina 6, *filamentis basi liberis*. Spiculæ plerumque multifloræ, flosculis 1–pluribus bipaleaceis.	
Palea superior lata, bicarinata, *carinis alatis*. Squamulæ 3, normales. Stylus brevis, *cito* 2–3–4-partitus	10. *Guadua*.
Palea superior plerumque angusta, bicarinata, carinis *non alatis*. Squamulæ plerumque 3, normales, raro 1–2–3 abnormales. Stylus vel subbrevis, cito 3-fidus vel basi subbulbosus profunde 2–3-fidus, vel longus, apice tantum 2–3-fidus	11. *Bambusa*.
Glumæ interdum gemmiparæ. Stamina 6, filamentis *basi monadelphis*. Spiculæ *subovatæ* vel *oblongæ*. Squamulæ abnormales 1–2–3, aut abortu nullæ	12. *Gigantochloa*.
	13. *Oxytenanthera*.
Spiculæ *longæ*, *cylindricæ*, angustæ. Squamulæ *nullæ* . . .	

IX. Nastus.

Jussieu, Gen. Plant. 39 (1791); Kunth. Enum. 429; Suppl. tab. 32. fig. 3; Lam. Ill. t. 264. fig. 1 *b, c, d*; Endl. Gen. Plant. no. 908. *Stemmatospermum*, P. de B. Agrost. 144, tab. xxv. fig. 5 (1812). *Chloothamnus*? Büse in Pl. Jungh. i. 387; Miq. Fl. Ind. Bat. iii. 414. *Bambusæ*, sp., Bory.

Spicula sursum deorsumque imperfecta, *brevipedicellata*, compressa, disticha, 5–7-flora, flosculis 4–5 inferioribus unipaleaceis, neutris, glumis similibus sed gradatim increscentibus, *flosculo* 1 (*penultimo*) *bipaleaceo*, hermaphrodito; terminali *pedicellato, tabescente, conspicuo*. *Glumæ* 2, breves, coriaceæ, hirsutæ, *nunquam gemmiparæ*. *Palea* inferior costato-nervosa, nervis prominulis, apice brevi-mucronata, superiorem bicarinatam profunde canaliculatam subæquans. *Stamina* 6, antheris apice bilobis, connectivo non elongato. *Stylus* ad basin usque trifidus, vel potius styli 3, stigmatibus brevibus, interne plumosis. *Squamulæ* 3, ciliatæ, integræ, obtusæ, inæquales, duæ majores. *Caryopsis* glabra, basi indurata, stylorum basibus coronata, ovato-conica.

Gramina in Borbonia, Madagascaria? et Sumatra? indigena, arborea, ramis e nodis fasciculato-verticillatis, apice floriferis. Folia coriacea, angusta, venulis transversis nullis vel inconspicuis. Vaginæ apice *longe fimbriatæ*. Inflorescentia panicula terminalis, bis terve composita.

Limited as above, *Nastus* is certainly a very good genus, and is a very interesting connecting link between the *Triglossæ* and the true Bamboos. I have no doubt concerning the identity of Jussieu's plant; for he states that he made his description of his genus *Nastus* from a specimen of Commerson's, collected in Bourbon, under the name of "Calumet des hauts," and I have, through the kindness of M. Brongniart, seen a specimen, with the same name, in the Paris herbarium, from the herbarium of Du Petit Thouars. Jussieu certainly ascribes "Styli 2 aut stylus profunde 2-fidus," instead of Styli 3 aut stylus profunde 3-fidus; and this error, I presume, induced Palisot de Beauvois to create his genus *Stemmatospermum*. I am not acquainted with *Chloothamnus* of Büse, except from the description of the genus given by Miquel, and, with the sole exception of no mention being made of the terminal barren pedicel, I cannot discover any difference between it and *Nastus*. It is, however, very interesting that a plant which was supposed to be confined to a very considerable elevation (3000–4000 feet above the sea) in Bourbon, should also be found in Sumatra, probably in a similar volcanic district. A note attached to a specimen in the Paris herbarium states that it was found in Madagascar. Raspail, in the Ann. des Sci. Nat. 1st ser. v. 442, and Sprengel also, have given such a comprehensive scope to *Nastus* that it would include nearly all Bamboos, whether with 3 or 6 stamens; hence have arisen the numerous synonyms and much confusion.

Species vera unica tantum.

1. N. Borbonicus, Gmel. Syst. edit. 13. ii. 580 (1791). Spiculis pedicellatis 6–7-*floris*, flosculis 4–5 inferioribus neutris, *penultimo hermaphrodito*, terminali *longe stipitato* tabescente hermaphroditum *subæquante*; foliis *angustis, acuminatissimis*, margine serrato-ciliatis.—Kunth in Journ. de Physique (1822), 148; Enum. 430; Suppl. 354, tab. xxxii. fig. 3; Nees in Linn. ix. 484; Rupr. *l. c.* 133, tab. xvii. fig. 42 (optima); Steud. *l. c.* 332. *N. paniculatus*, Sm. in Rees's Enc. n. 4, et herb. Smith! *Stemmatospermum verticillatum*, P. de B. *l. c.* 145. *Bambusa alpina*, Bory, It. i. 310, t. 12! (bona). *Chloothamnus chilianthus*? Büse, Pl. Jungh. 387; Miq. *l. c.* iii. 415; Walp. Ann. vi. 1045. *Bambusa arundinacea*, H. B. Pl. Æq. i. 71, non aliorum.

Hab. in ins. Borbonia, "regione Pays Brule," alt. 3000–4000 ped. s. m., *Commerson, Bory, Richard*!; Madagascar? ("Calumet des hauts," no. 101, herbier *Du Petit-Thouars* in herb. Mus. Paris.!); Sumatra in prov. Angkolæ sup., 1000–3000 ped., *Junghuhn*. v. s.

Culmus arboreus, 50-pedalis, fistulosus, raro ultra $2\frac{1}{2}$ poll. diametro, ramis (vel ramulis?) 5–12 poll. longis, basi foliatis, apice floriferis, semiverticillatis. *Folia* angusta, lineari-lanceolata, 2–4 poll. longa, 2–3 lin. lata, basi subattenuata, apice longissime acuminata, subtus vix pallidiora, venulis transversis obsoletis remotiusculis, margine serrato-ciliata. *Vaginæ* sulcato-striatæ, interstitiis lateralibus hirsutis, ore ciliis longis basi latis fimbriatæ, ligula inconspicua. *Panicula* subsimplex, ramis albido-fuscis, sericeo-tomentosis, spiculis pedicellatis vel fere sessilibus. *Spicula* oblonga, compressa, 5–7-flora, glumis 2, brevibus, muticis, nunquam gemmiparis; flosculis 4–5 inferioribus neutris, uni-paleaceis, nervoso-costatis, interstitiis pubescentibus vel hirsutis; penultimo neutris simillimo, bipaleaceo, hermaphrodito, paleis subæqualibus. *Palea* superior angusta, in sulco canaliculato rudimentum pedicellatum recipiens. *Genitalia* et *caryopsis* ut in genere descripto.

Bory, in the Itinerary quoted above, gives a very good drawing and interesting description of this plant. He says it is a most beautiful grass, flowering in September and October, when the stamens are exserted and hanging from the spiculæ. It is quite an alpine plant, and forms a well-marked and remarkable belt all round the island of Bourbon, interrupted only in places where the flow of lava prevents vegetation.

Species valde incerta et sine dubio anomala, stylo bifido.

2. N. BARBATUS, Trin. in Act. Petrop. *l. c.* 627, sub nom. *Bambusa barbata*. "Spiculis *sessilibus*, in *fasciculos* dense *aggregatis*, 5-floris, foliis *latis*, ovato-oblongis, basi subcordatis."—Ruprecht, *l. c.* 132, tab. xvii. fig. 41; Steud. *l. c.* 332.

Hab. in Brasilia, in collibus sylvaticis Bumadinhæ, *Riedel*. s. v. Ruprecht.

"*Culmus* 20–25-pedalis, ramis paniculatis, ad internodia ramulos 2–3-nos, basi floriferos, medio oligophyllos vel aphyllos, apice spiculas capitatas emittentibus. *Folia* ovato-oblonga, 6–$8\frac{1}{2}$ poll. longa, 16–18 lin. lata, basi rotundata, subcordata, longe petiolata, plicata, opaca, nervis secundariis 10–11, venulis transversis infra prominulis remotis. *Vaginæ* infra petiolum 3-linealem dense unilateraliter sericeo-barbatæ, ore fimbriatæ. *Spiculæ* in fasciculos dense aggregatæ, sessiles, 3–5 lin. longæ, 4–5-floræ, glumis inæqualibus, obtusis (interdum gemmiparis?) *Flosculi* 2–3 inferiores neutri, lævigati, glabri, nervosi, glumis similes. *Palea* inferior (flosculi penultimi hermaphroditi) acuta, superior involuta, pedicello flosculi sterilis longo, firmo. *Squamulæ* æquales, lanceolatæ, nervosæ. *Stylus* superne *bifidus*. *Caryopsis* hirsuta, attenuata." "Quoad spiculas affinis *N. Borbonico*, quoad habitum autem *Guaduæ distortæ*."—*Ruprecht*, desc. et icon.

It will be observed from the above description, which is the only acquaintance I have with this plant, that it is widely separated from *Nastus Borbonicus*, especially if the drawing is correct, in the glumes being occasionally gemmiparous. I do not feel certain to what genus it does really belong, and have therefore kept it where Ruprecht placed it.

NASTUS ARUNDINACEUS, Sm. *l. c.* et Raspail, *l. c.* = *Bambusa arundinacea*, W.
= *Melocanna bambusoides*, Trin.
N. BACCIFERA, Raspail, *l. c.* = *Beesha capitata*, Munro.
N. CAPITATUS, Kunth, Gram. i. 325, = *Chusquea scandens*, Kth.
N. CHUSQUE, H., B. et K. Nov. Gen. i. 201, = *Guadua angustifolia*, Kth.
N. GUADUA, Spr. Syst. ii. 113,

N. HUMILIS, Hassk. Cat. Hort. Bot. 19, nomen tantum.
N. LATIFOLIA, Spreng. *l. c.* = *Guadua latifolia*, Kth.
N. MACROSPERMA, Raspail, *l. c.* = *Arundinaria macrosperma*, Mich.
N. QUILA, Rœm. et Sch. *l. c.* 1361, = *Chusquea quila*, Kth.
N. STRICTUS, Sm. et Raspail, *l. c.* = *Dendrocalamus strictus*, Nees.
N. TESSELLATUS, Nees in Fl. Afr. Aust. 463, = *Arundinaria tessellata*, Munro.
N. THOUARSII, Rasp., Spr. *l. c.* = *Bambusa thouarsii*, Künth.
N. TJANKORREH, Rœm. et Sch. *l. c.*, Hassk. *l. c.* = *Dinochloa tjankorreh*, Büse.
N. VERTICILLATUS, Sm. *l. c.* excl. syn. Lour. = *Bambusa verticillata*, Willd.
N. VIVIPARA, Rasp. *l. c.* t. 8. fig. 3. = *Bambusa Thouarsii*, Kth.

X. GUADUA.

Kunth, Journ. de Physique, 148 (1822), et Syn. Pl. Æquin. i. 252; Ruprecht, *l. c.* 128. *Guada*, Euseb. Nieremb. lib. 14. cap. 194. *Bambusæ*, sp., Humb. et Bonpl. Pl. Æq. i. 68 (1808); Nees in Agros. Bras. 531, et Linn. ix. 469; Endl. et alior. *Nasti* sp., Sprengel et Raspail.

Spicula sursum deorsumque imperfecta, cylindracea, multiflora, flosculis nonnullis inferioribus masculis, vel unipaleaceis neutris, sequentibus paucis vel plurimis bipaleaceis, hermaphroditis, terminali tabescente. Interdum spicula dioica. *Glumæ* 2, breves, interdum gemmiparæ. *Palea* inferior multinervia, plerumque ovata et brevimucronata, margine fimbriata vel glabra; superior lata, plurinervia, marginibus incurvis, bicarinata, carinis plerumque *late alatis*. *Stamina* 6. *Squamulæ* 3 (in *G. macrostachya* 2 basi coalitæ, sed tertia libera), plerumque obtusæ, basi multinervosæ, superne fimbriatæ. *Stylus* plerumque cito trifidus vel bifidus, portionibus styli raro iterum divisis ut in *G. tagoara* et *G. latifolia* (stigm. 4). *Stigmata* vel brevia vel longa, interdum pulchre plumosa vel pilosa, interdum membranacea expansa marginibus argute denticulatis. *Caryopsis* ovalis vel lineari-oblonga, apice hirsuta vel pubescens, bulbo styli persistente sæpe aucta.

Gramina exclusive Americana Tropica, in Brasilia, Nova Granada, Mexico, Venezuela, Quito, Guiana, et Peru crescentia, culmis arboreis, ramosis, ramis junioribus sæpissime pungentibus et spinosis. *Folia* vel lata vel angusta, plana, petiolata, petiolo glabro vel hirsuto, venulis transversis plerumque obsoletis vel nullis, vaginis ore plerumque ciliatis. *Inflorescentia* variabilis, vel terminalis, panicula nunc subsimplex, paucispiculata, nunc decomposita, ramis divaricatis, vel sæpe in eodem ramo panicula terminalis, adjectis infra folia ad nodos ramulis spicigeris aphyllis. *Interdum* culmi foliiferi e florigeris discreti sunt.

This genus is kept up by most authors; but I am unable, in the absence of perfect fruit, to point out any good distinction, except a well-marked one in geographical distribution, between it and true *Bambusa*. Excepting a doubtful cosmopolitan species, *Bambusa vulgaris*, it may be said that all true Bambusas are confined to the East, and all true Guaduas to the West. The upper palea in *Guadua* has the keels much more distinctly and broadly winged than in any *Bambusa*. Ruprecht distinguishes *Guaduæ* as having "Flosculi non exacte distichi;" but in *G. latifolia* and many others the flowers are remarkably distichous. Nees, in Agrost. Bras. p. 532, makes *Guaduæ* a section of *Bambusa*, applying to it the definition of "Spiculæ teretiusculæ, stylus 2–3-partitus." This would of course include most of the Indian Bamboos. Rœmer et Schultes define the section *Guaduæ* as having "stylus brevis tripartitus, floribus inferioribus masculis vel neutris;" and this, again, would include *Bambusa tulda* and many other species of *Bambusa*. Kunth, in his 'Notice sur le genre *Bambusa*' (1822), separates *Guadua* from

Bambusa in consequence of the former having a trifid style whereas "the only two Bamboos", he was then acquainted with, *Bambusa arundinacea* and *B. stricta*, had bifid styles.

Conspectus Specierum.

Sect. I. Rami ramulive floriferi et foliiferi in eodem culmo.

Panicula in ramulis basi foliatis, semper, nisi raro in *G. latifolia*, terminalis.

Panicula *composita* ramis divaricatis recurvis . . . . . 1. *G. tagoara.*

Panicula simplex, spiculis *subracemosis*, 2–4 poll. longis, palea inferiore margine *fimbriata*. Folia lata . . . . . 2. *G. latifolia.*

Panicula fere simplex, spiculis glabris *glomeratis*, sæpe recurvis, palea inferiore margine *glabra*. Folia lata . . . . . 3. *G. glomerata.*

Panicula subsimplex, depauperata, racemosa, spiculis $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, dorso *hirsutis*. Folia *angusta* . . . . . 4. *G. macrostachya.*

Spiculæ *paucifloræ* in capitulis vel glomerulis distantibus aggregatæ, palea inferiore margine *glabra*. Folia *angusta* . . . . . 5. *G. capitata.*

Inflorescentia variabilis, vel panicula in ramulis foliiferis terminalis, vel rami spicigeri, aphylli, ad nodos fasciculati.

Spicula *multiflora*, 15–24 lin. longa. Folia 6–7 poll. longa, petiolo *glabro* 6. *G. angustifolia.*

Spicula 4–8-flora, 9–12 lin. longa. Folia supra *scabro-hispida*, 2–$3\frac{1}{2}$ poll. longa, petiolo *hirsuto* . . . . . 7. *G. Trinii.*

Spicula 2–4-flora, 5–7 lin. longa. Folia *glabra*, 3–4 poll. longa, petiolo *glabro* . . . . . 8. *G. distorta.*

Spicula 4–8-flora, 6–10 lin. longa. Folia 4–5 poll. longa, utrinque *pubescentia* vel *tomentosa*, petiolo *tomentoso-pubescente* . . . . 9. *G. virgata.*

Sect. II. Culmi floriferi a foliiferis distincti.

Spiculæ *magnæ*, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longæ, 8–14-floræ. Folia 8–15 lin. lata, brevissime petiolata . . . . . 10. *G. amplexifolia.*

Panicula supra decomposita, ramis tandem *pendulis, refractis*, spiculis 9–12 lin. longis. Folia 5–6 lin. lata, 8 poll. longa, petiolo hirsuto . 11. *G. refracta.*

Panicula supra decomposita, ramis divaricatis, spiculis 6–9 lin. longis. Folia $2\frac{1}{2}$–5 lin. lata, 4–7 poll. longa, petiolo *hirsuto* . . . . 12. *G. paniculata.*

Panicula supra decomposita, ramis divaricatis, spiculis 9–10 lin. longis. Folia 4–5 lin. lata, 3–$4\frac{1}{2}$ poll. longa, petiolo *hirsutissimo* . . . 13. *G. Venezuelæ.*

1. G. TAGOARA, Kunth, Enum. 434 (1833). Ramulis infra nodos latos strigosis, foliis latissimis (2 poll.), 9–10 poll. longis, vaginis ore fimbriatis; spica composita, ramis divaricato-recurvis; spiculis arcuatis, 12–15 lin. longis, 6–8-floris; palea inferiore margine ciliolata.—Rupr. *l. c.* 131, tab. xvi. fig. 40; Steud. *l. c.* 334. *Bambusa tagoara*, Nees in Agrost. Bras. 532, et Linn. ix. 470; Spix et Mart. Veget. Form. t. i. fig. 9; Rœm. et Sch. *l. c.* 1349; Lindl. in Penny Cycl. vol. iii.

Hab. in Brasilia: in sylvis alt. 1800 ped. s. m. montis Serra do Mar versus Guarantigueta, prov. St. Pauli ("Tagoara" incolis), *Martius*; Minas Geraes, *Burchell*, no. 2074! (folia tantum); Organ Mts.!, *Wilkes* (folia). v. s.

Culmus 20–30-pedalis, spinosus (teste Burchell), 4–6 poll. diametro, nunc erectus, nunc curvatus, superne *vage ramosus* et *ramulosus*, internodiis $\frac{1}{2}$–$1\frac{1}{2}$-pedalibus. *Ramuli* laxi, propendentes, læves, infra nodos

latos strigosi, apice spicas compositas, ramis dissitis, elongatis, divaricatis, recurvis ferentes. *Folia* oblongo-lanceolata, acuminata, glabra, e basi rotundata in petiolum brevem canaliculatum attenuata, 9–10 poll. longa, 2–2½ poll. lata. *Vaginæ* basi læves, apice sulcatæ, glabræ, ore truncatæ, fibroso-ciliatæ. *Spica* terminalis, *composita*, inferne foliosa, ramis alternis, *divaricato-recurvis*, scabriusculis; spiculis ad nodos ramulorum sessilibus, ternis, apicem versus solitariis. "*Bracteæ* aliquot imbricatæ aridæ ad ramorum ortum, et inter eas ramulus sæpe progenitus brevis, recurvus, spiniformis, nudus" (*Nees*). *Spicula* subcylindrica, acuminata, recurva, 12–15 lin. longa, scabriuscula, fusco-viridis, 6–8-flora, flosculis 3–4 perfectis, rhachilla compressa lævi valida. *Glumæ* 2, breves, ovato-acutæ, 3–5-nerviæ. *Flosculi* 2 inferiores, neutri, 1-paleacei, 9-nervii, glabri, margine obsolete ciliati. *Palea* inferior (flosculi fertilis) neutris similis, margine ciliata, 2½ lin. longa.; superior æqualis vel paulo longior latiorque, magis membranacea, obtusa, lateribus acute inflexis bicarinata, carinis alatis, membranaceis, ciliatis. *Rudimentum* flosculi sterilis terminalis pedicellatum. *Squamulæ* 3, tenuissime membranaceæ, ovatæ, acutæ, lacero-ciliolatæ. *Stylus* ad basin fere bipartitus, cruribus (altero saltem) bifidis; hinc stigmata 3–4, filiformia, pubescentia, vix plumosa. *Ovarium* (immaturum) obconicum, trigonum, styli basi incrassata coronatum, superne pubescens.

This is distinguished from all other species by the width of the leaves far exceeding that of the following species (called *latifolia*), which is certainly closely allied, but has much longer spiculæ. It is one of the numerous plants already referred to at p. 47 as being called Tagoara or Taquarra by the inhabitants of the country in which it grows.

In one of Burchell's specimens the leaves are 2½ inches broad, and about a foot long, with 24–28 secondary nerves, and numerous conspicuous transverse veinlets; and on one of the sides of the vaginæ near the top there is a curious dense bundle of short hairs, and the ciliæ are often more than half an inch long. In Wilkes's specimen the leaves are narrower and the ciliæ have fallen; but there is the same curious alternating bundle of hairs on the vaginæ. These two I suppose to be the same as the plant referred to by Ruprecht in a note at p. 131 of his work referred to above, where he says,—"Alia prope Rio de Janeiro provenit species [*Guaduæ*], ramis spicigeris recurvatis *G. tagoaræ* proxima, vaginis vero imprimis superne villosis, foliis pedalibus et ultra, 2½ poll. latis, spiculis 6–9 lin. distincta." I may therefore be wrong in including Burchell's and Wilkes's plants, as I have done, in *G. tagoara*; but I have not seen any authentic specimens of that plant. Burchell's second specimen is from the rambling upper portion of the culm; the short branches are pendulous, the ciliæ are as long as described above, and the bundle of hairs on the vaginæ is occasionally present and occasionally absent. There are three rather strong recurved spines at each joint of the culm, the internodes of which are scabrous.

2. G. LATIFOLIA, Kunth, Syn. i. 254 (1822); Enum. 433; Suppl. 357. Ramulis subrecurvatis pungentibus; foliis 13–15 lin. latis, 5–6 poll. longis; vaginis pilis rigidis sparsim obsitis (*Kunth*), demum glabris, ore ciliis rigidis fimbriatis; panicula sæpe dioica, plerumque subsimplici, ramis adpressis 1–2-spiculatis spiculis; *arcuatis*, 2–4 poll. longis, 8–10-floris; palea inferiore margine *densissime ciliato-pilosa*.—Nees, Agrost. Bras. 534, adnot.; Rupr. *l. c.* 128, tab. xvi. fig. 33; Steud. *l. c.* 333; Grisebach, *l. c.* 528. *Bambusa latifolia*, H. et B. Pl. Æquin. i. 68, t. 21!; H., B. et K. Nov. Gen. i. 200; Spix et Martius, *l. c.* t. v. fig. 2; Rœm. et Sch. *l. c.* 1348; Lindley, *l. c.* *Nastus latifolia*, Spr. S. V. i. 113. *Bambusa fragilis*, Spruce, MS. in herb. Benth.

Hab. in Brasilia: in sylvis umbrosis humidis ad ripam fluvii Cassiquiare (Missionis del alto Orinoco y Rio Negro), *Bonpland*; secus Rio Negro inter Barcellos et San Gabriel, *Spruce*, no. 1954!; Trinidad, *Purdie*; et Venezuela, teste *Grisebach*.

Culmus 24-pedalis, apice tantum ramosus et subnutans, nitidus, læte virens, diametro 4 poll., internodiis bipedalibus (*Kunth*), pedalibus (*Spruce*), spathis intus glaberrimis, extus pilis sparsis rigidis obsitis, tardius deciduis tectis; ramulis subrecurvatis, subpungentibus, dense foliosis, "fragilibus." *Folia* lineari-oblonga, acuminata, basi rotundata, in petiolum 3 lin. longum, glabrum, "basi subtumidum attenuata," 5–6 poll. longa, 15 lin. lata (*Kunth*), in ramulis floriferis, a me visis, 4–7 poll. longa et 7–10 lin. lata, margine serrata, utrinque glabra, nervis secundariis sub 20, venulis transversis manifestis, distantibus. *Vaginæ* striato-sulcatæ, pilis rigidis adpressis sparsim obsitæ (*Kunth*), demum glabræ, ore ciliis paucis rigidis fimbriatæ, ligula brevi. *Panicula* fere simplex, interdum dioica, in ramulis foliatis terminalis, 4–6 poll. longa, adjectis (rarissime) ramis obsoletis, spiculis 1–2–3, ad nodos fasciculatis. *Spicula* angusta, cylindrica, subsessilis, 2–4 poll. longa, acuminata, 8–10-flora, floribus inferioribus nonnullis masculis, rhachillæ articulis interdum 4½ lin. longis. *Glumæ* 2, ovatæ, glabræ. *Palea* inferior (flosculi bipaleacei) nervis 17–20 validis striata, apice mucrone cito caduco acuminata, sæpe medio dorso, basin versus, fasciculo pilorum hirsuta, margine *pilis ferrugineis dense ciliata*; superior brevior, bicarinata, carinis superne præcipue late alatis, inter carinas 4–5-nervia et hirsutiuscula. *Squamulæ* 3, oblongo-ovatæ, margine fimbriatæ, subæquales, membranaceæ, glabræ, apice vix nervosæ, ima basi interdum coalitæ. *Stamina* 6, "antheris purpureis" (*Spruce*). *Stylus* profunde 3–4-partitus, violaceus, basi conicus et pilis subglandulosis hirsutus. *Ovarium* ovato-oblongum, acuminato-rostratum, hinc convexum, inde planum sulco longitudinali.

Spruce says that this is very slender and brittle in the flowering portion. I have already, at p. 3, stated how very rarely this plant has been found in flower. Ruprecht states that he had seen but a single spicula; and Nees states, in Martius's 'Flora Brasil.,' that there was no specimen in any herbarium he had access to. Kunth states that his description and figure were taken from a specimen presented by Humboldt, who says that the plant is very abundant on that part of the Orinoco which is below the cataracts. I have quoted Trinidad as a locality on the authority of Grisebach. The very long spiculæ appear to keep this distant from all other species. The drawing in the Plant. Æquin., which is not a good one, is more like the following species than any specimen I have seen of *G. latifolia*.

3. G. GLOMERATA, Munro. Internodiis culmi apice scabris, ramis ramulisque *subrecurvatis*; foliis latis vel interdum angustis, ovato-lanceolatis vel lineari-lanceolatis, 3–5 poll. longis, 5–15 lin. latis, in eodem ramulo; vaginis superne hirsutis vel glabris, membrana cupuliformi terminatis, ore fimbriatis; panicula dioica, brevissima, contracta, rhachi fere nulla, spiculis glomeratis, 1–2 erectis, reliquis refractis pentibus palea inferiore *margine efimbriata*.

Hab. in Brasilia: in vicinibus Barra, Gapo de Rio Negro, *Spruce*, no. 1196! v. s.

Culmi ——pedales, "2–3 poll. diametro, solidi, arcuati, ramulis intertextis, fruticeta fere impenetrabilia struentes, nodis spinis validis, fasciculatis, decurvis armatis." *Rami* breves, internodiis 2–4 valde inæqualibus, plerumque scabris, ramulos breves, apice floriferos, 1–3 ad nodos ferentes. *Folia* valde inæqualia, eodem ramo lata (15 lin.) vel angusta (5 lin.), subtus discoloria, 3–5 poll. longa, apice attenuata et denique mucronata, e basi subrotund ta vel cuneata in petiolum brevem subglabrum attenuata, glabra vel supra uno latere tactu scabra, margine serrata, nervis secundariis 18–20 vix conspicuis, venulis transversis nullis vel obsoletis, suprema spiculas superantia. *Vaginæ* basi læves,

nitidæ, superne sulcato-striatæ et pilis brevibus canescentibus subhirsutæ, demum glabræ, infra petiolum membrana chartacea terminatæ, ore ciliis pallidis fimbriatæ. *Panicula* dioica, rhachi brevissima, *fere nulla*; spiculis 5–8–10, inæqualibus, glomeratis, 1–2 erectis, reliquis pendentibus, vix e vagina suprema exserta et folio superata. *Spicula* (mascula tantum visa) 1–2 poll. longa, nervoso-costata, 7–10-flora, flosculis 2–3 inferioribus unipaleaceis, neutris, sequentibus 3–4 bipaleaceis, masculis, 2–3 terminalibus gradatim tabescentibus, rhachillæ articulis brevissimis. *Glumæ* 2, breves, mucronatæ. *Flosculi* neutri lati, nervis 16 validis notati, subobtusi, breviter mucronati. *Palea* inferior (flosculi masculi) neutris simillima sed longior, 7–9 lin. longa, mucrone interdum incurvo; superior multo brevior, multinervia, lata, bicarinata, carinis late alatis et superne longe ciliatis. *Stamina* 6, filamentis brevibus. *Squamulæ* 2–3 in flosculis masculis, ovatæ, obtusæ, multinervosæ. *Styli* rudimenta nulla.

Spruce, in his notes, mentions having sent male and female specimens; but all the spiculæ I have examined contain male flowers only. In foliage this approaches very closely to *G. latifolia*; but the spiculæ are very different, and in this latter respect it approaches *G. amplexifolia*, from which, however, it is well distinguished by having very simple instead of compound inflorescence.

4. G. MACROSTACHYA, Rupr. *l. c.* 129, tab. xv. fig. 35. Ramulis tenuibus apice floriferis, foliis *angustis*, petiolo vix ullo, 4–8 poll. longis, 3–6 lin. latis, vaginis glabris ore *efimbriatis*, panicula terminali subsimplici, spiculis $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, palea inferiore sæpe *tota superficie hispida*.—Steud. *l. c.* 333; *G.? dioica*, Steud. *l. c.* 334.

Hab. in Guiana Gallica, *Leprieur*! no. 1019; ad mare, *Sagot*!; in Brasilia, prov. Para, Santarem, *Spruce*, no. 420! (folia). v. s.

Culmus 20–30-pedalis, spinosus, ramis lævibus, solidis, duris, e nodis subverticillato-ramulosis, glabris, foliatis, ramulis subpedalibus, apice floriferis. *Folia* angusta, brevissime acuminata, basi attenuata, petiolo vix ullo, 4–8 poll. longa, 3 (raro usque 6) lin. lata, utrinque glabra, subconcoloria, margine setulis minimis scabris obsessa, (in sicco) imprimis inferne convoluta, nervis secundariis 8–10, venulis transversis obsoletis. *Vaginæ* glabræ, ore efimbriatæ, ligula brevissima truncata. *Panicula* interdum dioica, ramulis terminalis, depauperata, spiculis subracemose vel fasciculatim aggregatis, sessilibus vel brevissime pedicellatis, rhachi hirsuta vel subglabra. *Spicula* $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, cylindrica, teres, 2–$2\frac{1}{2}$ lin. lata, rhachillæ articulis 3 lin. longis, attenuata, subrecta, obscure fuscescens, 6–12-flora, flosculis (inferioribus nonnullis incompletis) ovato-oblongis, chartaceis, multinerviis, dorso plus minus setulis diaphanis, sparsis strigoso-hirsutis, nervoso-striatis, hinc inde basi foliolo brevissimo munita, plerumque nuda. *Palea* inferior (flosculi fertilis) incompletis simillima sed major, $7\frac{1}{2}$ lin. longa, brevissime mucronata; superior brevior, lata, obtusa, carinis alatis, apice ciliata. *Squamulæ* 3 (4 fide Steudel), 2 interdum basi coalitæ inferne multinervosæ, superne longe fimbriatæ enervosæ et hirsutæ. *Stylus* cito 2–3-fidus, stigmatibus pilosis vel expansis et membranaceis. *Stamina* 6. *Ovarium* oblongum, apice attenuatum et pilosum.

This species has narrow leaves, very similar to those of *G. angustifolia*; but the spiculæ (sometimes very hirsute, but always more or less so) distinguish it at once from all other species with large spiculæ. The squamulæ are different from those of all other species. Two are generally, if not always, united at the base, and are deeply bifid to near the middle, many-nerved in the lower portion; the upper half has no trace of a nerve, but is covered over with very small hairs, which are only visible under a high power. None of the spiculæ which I have examined are diœcous.

5. G. ? CAPITATA, Munro. "Ramis glabris, usque ad capitulum florum vaginis tectis, foliis sublanceolato-linearibus, undique glabris, 6–10 poll. longis, 4–7 lin. latis, vaginis glabris, utrinque breviauriculatis, oreque brevissime fimbriatis, spiculis in capitulis vel glomerulis distantibus sessilibus aggregatis, palea inferiore angusta, *margine glabra.*"—*Bambusa capitata*, Trin. in Act. Petrop. *l. c.* 626 et icon. 337 ! non Willd. *Schizostachyum capitatum*, Rupr. *l. c.* 136, tab. xvii. fig. 46.; Steud. *l. c.* 332.

Hab. in Brasilia, in ripa flum. Pardo, *Riedel.* s. v. Trinius et Ruprecht.

"*Culmus* 15–20-pedalis, ramis simplicibus strictis, glabris, dense foliosis. *Folia* sublanceolato-lincaria, stricte arrecta, firma, undique glabra, 6–10 poll. longa, 4–7 lin. lata, subtus glaucescentia, nervis secundariis uno latere 5, altero 6. *Vaginæ* glabræ, utrinque auricula brevi auctæ, ore cirrulis perbrevibus fimbriatæ, ligula brevissima truncata. *Inflorescentia* terminalis, verticillato-capitata, capitulis vel glomerulis 1–2 poll. diametro, e fasciculis nonnullis spicularum paucarum, patentibus et divergentibus. *Spicula* 3–4-flora, rhachillæ articulis brevissimis, glabris, flosculis 3 inferioribus hermaphroditis, obtusiusculis, terminali tabescente. *Glumæ* obtusæ, multinerviæ, sæpe gemmiparæ. *Palea* inferior 5–6 lin. longa, 13-nervia, glabra, superior æquilonga, vel paulo longior, conduplicata, marginibus contiguis dissite bicostata et præterea tenue 9-nervia. *Squamulæ* 3 vel 2 (teste Trinius), basi nervosæ obtusæ et superne fimbriatæ. *Stamina* 6. *Stylus* puberulus, basi simplex, tunc in stigmata 3 plumosulo-pubescentia divisus. *Caryopsis* sublinearis, fusca, apice puberula, dorso sulco lato et profundo excavata et linea elevata percursa."—*Trinius* et *Ruprecht.*

In the compound structure of the fascicle of spiculæ, very well and carefully represented by Ruprecht in the drawing quoted above, this species resembles *Schizostachyum*; but the styles and caryopsis are very different, and show that the plant cannot belong to the section of berry-bearing Bamboos. The drawings do not represent the keels of the upper palea as being as broadly winged as is usual in the other species of *Guadua*.

6. G. ANGUSTIFOLIA, Kunth, Syn. i. 253; Enum. 433; Suppl. 357. Ramis ante explicationem pungentibus, recurvatis, demum erectis, foliis *angustis*, 5–8 lin. latis, 6–7 poll. longis, vaginis glabris, plerumque efimbriatis, inflorescentia variabili, panicula interdum in ramulis foliatis terminali, interdum aphylla ad basin ramulorum locata, spiculis 15–24-linealibus, angustis, palea inferiore *glabra* vel raro dense sed brevissime *hirsutiuscula*.—Rupr. *l. c.* 129, tab. xv. fig. 36; Steud. *l. c.* 333. *Bambusa guadua*, H. et B. Pl. Æquin. 168, t. 20 ! bona; Nov. Gen. et Sp. i. 200; Turpin in Mém. du Mus. v. 486 (1819), t. i. figg. 12 & 13; Rœm. et Sch. *l. c.* 1347; Lindl. in Penny Cyc. (1835). *Nastus guadua*, Spreng. Syst. ii. 113; Raspail, *l. c.* v. 442.

Hab. in Nova Granada, in declivitate occidentali Andium a litore ad 2400 ped. s. m. ("Guadua," incolis), *Humboldt, Goudot* ! ; La Paila, *Holton*, no. 105 ! ; prov. de Bogota ! *Triana*, no. 1040 ! *Lindig* ; Ecuador, Quito, *Humboldt* ; Peru, Lima ! *Wilkes*, var. spiculis dorso brevissime hirsutiusculis. v. s.

Culmus arboreus erectus, a basi ad summitatem ramosus, 30–36-pedalis, "diametro 6-pollicari," spathis externe setis rigidis obsitis, intus glabris, tardius deciduis, "Tabasheer fundens," nitidus, ramis teretibus congestis, ante explicationem pungentibus, recurvatis, demum erectis, "internodiis inferioribus pedalibus," superioribus tenuibus, 1–3-pollicaribus. *Folia* plerumque angusta, lineari-lanceolata, 6–7 poll. longa, et sub 5 lin. lata, interdum in eodem ramo 9–10 lin. lata, acuminata, basi attenuata in petiolum glabrum, supra et margine scabra, subtus vix pallidiora, pilis longis sparsis

interdum hirsuta, nervis secundariis 14–16 vix elevatis, venulis transversis obsoletis. *Vaginæ* plerumque glabræ, apice truncatæ, sæpe efimbriatæ; interdum, præcipue in ramulis junioribus, ciliæ paucæ pallidæ cito deciduæ adsunt; ligula brevissima, fere nulla. *Inflorescentia* variabilis, interdum panicula depauperata, fere spicata, 2–4-nodosa, spiculis paucis, 1–3, ad nodos sessilibus, in ramulis terminalis, interdum, eodem ramulo, spiculis paucis infra folia fere ad basin ramuli locatis, interdum paniculæ 2–3, terminali similes, aphyllæ, ad nodos ramorum, cum spiculis 1–2 fasciculatis. *Spicula* semper angusta, 1–2 lin. lata, cylindracea, 15–24 lin. longa, subarcuata, 7–8–12-flora, læte stramineo-fuscescens, basi apiceque attenuata, flosculis inferioribus nonnullis masculis, supremis tabescentibus, intermediis hermaphroditis, rhachillæ articulis brevibus, uno latere sulcatis, fere glabris. *Glumæ* breves, carinatæ, glabræ. *Palea* inferior acuta, nitida, sæpe glabra vel brevissime adpresse hirsuticula, dorso obsolete nervosa; superior vix brevior, carinis late alatis et superne fimbriatis, 8–10-nervia. *Squamulæ* 3, tenuissime membranaceæ, basi callosæ et multinervosæ, oblongæ, obtusæ (acutæ, fide Kunth). *Stylus* cito bi- trifidus in stigmata 2–3, longa vel brevia (in eadem spicula), pulchre plumosa vel interdum expansa, submembranacea (teste Rupr.). *Ovarium* apice conico hirsutum, stipitatum.

I have fortunately seen several specimens of this plant in flower, and have thus had an opportunity of observing how extremely variable the inflorescence, as described above, is. The bright yellowish-brown-coloured, shining, long, narrow spiculæ afford very good marks for distinguishing this species at sight from all others. Kunth's mistake in assigning a diameter of 16 inches to the culm has been copied by nearly all other writers on Bamboos. Humboldt says this is found abundantly in the mountains of Quindiu, forming forests several leagues in extent, growing in hot valleys and at moderate elevations.

7. G. Trinii, Rupr. *l. c.* 130, tab. xv. fig. 38. Ramis *tuberculato-asperis*, foliis angustis, 3–3½ poll. longis, supra scabro-hispidis, *petiolo hirsuto*, vaginis *puberulis*, ore herbaceo-setulosis, panicula vel brevi subsimplici, vel longa et decomposita, spiculis ¾–1 poll. longis, 4–6-floris, palea inferiore *margine glabra*.—Steud. *l. c.* 333. ***Bambusa Trinii*, Nees in Linn. ix. 469.**

Hab. in Brasilia, *Sellow*! v. s.

Culmus ——pedalis, ramis tuberculato-asperis, lanuginoso-canis, ad originem spinis recurvatis sæpe oppositis. *Folia* anguste lanceolata, acuminata, basi cuneata in petiolum brevem *hirsutum*, glauca, 2½–3½ poll. longa, 2–3 lin. lata, margine scabra, supra scabro-hispida, subtus nisi ad petiolum et nervum medium fere glabra, nervis secundariis utrinque 3, venulis transversis nullis. *Vaginæ* puberulæ, ore setulosæ. *Inflorescentia* maxime irregularis—nunc panicula brevis, 4–5-stachya, in ramis spicigeris lateralibus, aphyllis cum foliosis *ramosissimis* mixtis, nunc ramorum validorum terminalis spicam exhibet prælongam, racemoso-decompositam, interrupte glomerulifloram, aphyllam. *Spiculæ* subsolitariæ, ¾–1 poll. longæ, lanceolatæ, acuminatæ, nitidæ, virides vel stramineæ, 4–6–8-floræ, rhachillæ articulis 1½ lin. longis, flosculis demum squarroso-patentibus, 1–2 inferioribus et 1–3 superioribus sterilibus, intermediis perfectis. *Glumæ* acuminatæ, 7–9-nerves, mucrone brevi terminatæ. *Palea* inferior 7–13-nervis, margine glabra, superiorem ovalem, apice obtuso denticulato, carinis alatis, inferne lævibus apice scabriusculis, æquans. *Squamulæ* 3, obtusæ, plicatæ, basi nervulosæ, inconspicue fimbriatæ, tertia angustior. *Stylus* basi bulbosus, cito trifidus in stigmata 3 plumosa.

The inflorescence of this species is remarkably variable; in the compound state it has

an appearance very similar to some forms of *Bambusa tulda*, Roxb. There are frequently some barren abortive spiculæ at the base of the perfect ones. .

8. G. DISTORTA, Rupr. *l. c.* 131, tab. xvi. fig. 39. "*Ramis lævibus*, foliis lanceolatis, 3–4 poll. longis, 5–6 lin. latis, *glabris lævibusque*, vaginis glabris, ore nudis vel brevissime fimbriatis, panicula fere simplici, spiculis 5–7 lin. longis, paucifloris, palea inferiore *margine glabra*."—Steud. *l. c.* 333. *Bambusa distorta*, N. ab E. in Linn. ix. 470.

Hab. in Brasilia, *Sellow*. s. v. Ruprecht et Nees.

"*Culmus* (ramus crassior) opacus, striatus, lævis, ramis spicigeris recurvatis. *Folia* lanceolata, 3–4 poll. longa, 5–6 lin. lata, basi rotundata, petiolata, glabra, lævia, margine scabra, nervis secundariis 5–6, venulis transversis obsoletis, remotiusculis. *Vaginæ* glabræ, ore nudæ vel brevissime setulosæ. *Spicæ* e nodis glabris ramorum, fasciculatæ, divaricatæ, aphyllæ, ramulis oligo (2–4)-phyllis, apice brevispicatis, intermixtis spiculis glomeratis pluribus, tereti-oblongis, demum complanatis. *Spicula* 5–7 lin. longa, pauciflora, glabra, flosculis 1–2–3 perfectis, terminali masculo vel neutro longe pedunculato. *Palea* inferior (flosculi fertilis) nervosa, mucronulata, margine glabra, superiorem late carinatam glabram subæquante. *Squamulæ* 3, breves, glabræ. *Stylus* cito trifidus. *Ovarium* apice pilosum. Valde affinis *G. Tagaoræ*, differt imprimis foliorum magnitudine et spiculis."—*Nees et Ruprecht.*

Judging from Ruprecht's drawing, this appears to me to be very closely allied to some states of *G. Trinii*.

9. G. VIRGATA, Rupr. *l. c.* 130, tab. xv. fig. 37. "Ramis *glabris lævigatis*, foliis lanceolatis, 4–5 poll. longis, 6–7 lin. latis, supra *scabro-pubescentibus*, vaginis superne breve tomentosis, panicula spiciformi, interrupta, virgata, spiculis sessilibus, palea inferiore *margine ciliata*."—Steud. *l. c.* 333. *Bambusa virgata*, Trin. in Act. Petrop. *l. c.* 624, icon. 338!

Hab. in Brasilia, in sylvis montium St. Geraldi, prov. Minarum, *Riedel.* s. v. Trinius et Ruprecht.

"*Culmus* 25-pedalis, diametro 2–3-pollicari, ramis glabris, lævigatis, laxis, ramulis fasciculatis inæqualibus, inferioribus mere et fere a basi floriferis, terminalibus foliiferis ex ipso apice floriferis, omnibus virgatis. *Folia* lanceolato-linearia, apice acuminata, basi in petiolum fere bilinealem tomentosogatis. pubescentem attenuata, 4–5 poll. longa, 5–7 lin. lata, supra scabra et pubescentia, subtus molle piloso-tomentosa et canescentia. *Vaginæ* superne brevitomentosæ, margine ciliatæ, utrinque productæ in auriculam brevem chartaceam, e marginibus emittentem cirrulos plures 1–2-lineales. *Panicula* spiciformis, angusta, interrupta, virgata, læte viridis, rhachi tereti, glabra, per internodia, ad summum pollicaria, emittens spiculas sessiles aut 3–4 aut solitarias. *Spicula* subcylindrica, attenuato-acutissima, nitida, 4–8-flora, 6–10 lin. longa, læte straminea, recta, rhachillæ articulis turbinatis, brevibus. flosculis inferioribus sterilibus, sequentibus masculis (an semper?), penultimo hermaphrodito. *Gluma* 2, interdum gemmiparæ, oblongo-ovatæ, inferior bicarinata, superior vix longior, mucronulata. 7-nervis. *Palea* inferior 9–15–17-nervis, nervis pertenuibus, apicem versus magis conspicuis, ovata, apice mucronata, margine ciliata; superior (hermaphroditi) inferiorem æquans, lateribus inflexis, bicarinatis, carinis alatis. *Squamulæ* 3, inæquales, tertia angustior, brevior et glabrior. *Stamina* 6. *Ovarium* cum stylis indescriptum."—*Trinius* et *Ruprecht.*

I imagine that only undeveloped spiculæ in an immature state have been seen and described by both the authors above quoted.

10. G. AMPLEXIFOLIA, Presl in Rel. Hænk. i. 256 (1830). Ramis *infra nodos scabriusculis*, ramulis foliiferis erectis, vel abortivis spinosis refractis, foliis 8–15 lin. latis, 4–12 poll. longis, vaginis superne *hirsutis* vel *glabris*, *auriculato-fimbriatis*, panicula (in culmo florifero tantum) elongata, decomposita, basi aphylla, spiculis ad nodos ramulorum paniculæ fasciculatis, longis, erectis, palea inferiore *margine glabra*.—Kunth, Syn. 434; Rupr. *l. c.* 128, tab. xiv.; Steud. *l. c.* 333. *Bambusa amplexifolia*, Rœm. et Sch. *l. c.* 1348.

Hab. in Mexico, *Presl*; Santa Cruz, *Seemann*, no. 425!; Panama, Isthmus, Chagres, *Fendler*, no. 381!; Nova Granada, Carthagena, *Sutton Hayes*, no. 622!; Venezuela, prope Guigui, alt. 2000 ped. s. m., *Fendler*, 1629! v. s.

Culmus ——pedalis, basi diametro 2 poll., spathis magnis, pruinoso-glaucis, apiculo triangulari 10 poll. longo, 8 poll. lato, utrinque hirsuto, ramis foliiferis dichotomis, teretibus, striatis, lævisculis, infra nodos scabriusculis, interdum abortivis, spiniformibus, refractis. *Folia* membranacea, oblongo-lanceolata, sensim in acumina elongata, e basi ovata, brevissime petiolata, interdum amplectantia, margine scabro-serrata, subconcoloria, utrinque glabra, sed supra interdum tactu scabra, nervis secundariis 14–18, venulis transversis nunc obsoletis, nunc plus minus conspicuis. *Vaginæ* superne striatæ, glabræ vel pubescentes, margine ciliatæ, ore plerumque auriculato-fimbriatæ, auricula lineari sat longa, margine superiore longe setosa, sæpe cito decidua. *Inflorescentia* paniculata, composita, aphylla, rhachi semitereti, striata, hirsuta, ramo inferiore 10 poll., reliquis 1–3 poll. longis, internodiis $1\frac{1}{2}$–3 poll. longis, spiculis, ad nodos ramulorum fasciculatis, ternis quaternisve. *Spicula* cylindracea, basi apiceque attenuata, arcuata, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, 8–14-flora, flosculis 1–3 inferioribus et 2–3 superioribus unipalcaceis neutris, rhachillæ articulis brevibus, sulcatis. *Glumæ* 2, rotundatæ, mucronulatæ, multinerves, glaberrimæ. *Palea* inferior (flosculi fertilis) neutris similis sed longior, 7 lin. longa, ovata, dorso nervoso-costata, margine membranacea, glabra, brevissime mucronata, multi (20 et ultra)-nervis; superior $\frac{1}{3}$ vel $\frac{1}{4}$ vel vix brevior, ovato-rotundata, dorso hirsutula, marginibus inflexa, flexuris sat late carinatis et alatis, alis apicem versus ciliatis, multinervibus. *Squamulæ* 3, longæ, basi callosæ et multinervosæ, apice acuminatæ et fimbriatæ. *Stylus* basi simplex, tunc divisus in stigmata 3, vel tenuissima vel expansa et membranacea, pulcherrime plumosa. *Ovarium* stipitatum, apice conico hirsutum. *Caryopsis* lineari-oblonga, infra apicem constrictum.

The only specimens which I have seen in flower are those collected by Sutton Hayes, and these had no leaves attached. The remaining numbers which I have quoted are in leaf only, but they all agree remarkably well with Presl's very good description. The leaves in this species are much thinner than in *G. latifolia* and *G. glomerata*; and the inflorescence is very different from that of any of the species distinguished by having broad leaves and large spiculæ. The spiculæ are very similar to those of *G. glomerata*. Sutton Hayes says the plant is called "Cañabrava," and is very common in low wet land near Carthagena, and that it was also common on the Isthmus, but that he had never seen it in flower there.

11. G. REFRACTA, Munro. Culmo florifero aphyllo, paniculæ ramis cito *refractis*, fere simplicibus, spiculis subcompressis, 9–12 lin. longis, palea inferiore nervosa, dorso plerumque *glabra*, margine vix ciliata, foliis 4–9 poll. longis, 4–7 lin. latis, basi inæquilateris, petiolis *hirsutis*, vaginis sæpe pubescentibus, margine inconspicue ciliatis.

Hab. in Brasilia tropica, prov. Goyaz, *Burchell*, no. 7642! *Gardner*, no. 4063! v. s.

Culmi solidi, ramosi, 20–30-pedales, uncinati, juniores pubescentes. Foliiferi internodiis superne strigoso-hispidis, fere teretibus, sed uno latere linea longitudinali plus minus conspicue hirsuta impressis, superioribus vix 1½ poll. longis, ramulis gracilibus, 1–1½-pedalibus et ultra, ad nodos fasciculatis. *Folia* angusta, lineari-lanceolata, 4–9 poll. longa, 4–7 lin. lata, basi inæqualia, subrotundata vel cuneata, petiolata, petiolo brevi complanato utrinque vel subtus tantum pilis longis hirsuto, apice acuta, margine scabra, supra tactu scabra et interdum hirsutiuscula, subtus plerumque pilis longis vel brevibus hirsuta, vel juniora dense pubescentia, nervis secundariis conspicuis, uno latere 5–6, altero 4–5, venulis transversis nullis. *Vaginæ* inferiores hirsutæ, superiores plerumque superne pubescentes, in culmis junioribus hirsutissimæ, margine vix ciliatæ, ore ciliis paucis cito deciduis fimbriatæ, in junioribus biauriculatis, auriculis linearibus apice longe fimbriatis, ligula inconspicua. *Culmo* florifero aphyllo; *panicula* gracilis, internodiis superioribus 4–5 poll. longis, superne strigoso-hispidis, ramis plerumque solitariis, cito refractis, fere simplicibus, adjectis ramis 1–2 abortivis spiniformibus, rhachi strigoso-hispida, ad nodos spiculas pallidas 2–3 aut plures divaricatas gerentibus. *Spicula* 6–10-flora, basi valde attenuata, flosculis 1–2 inferioribus et 2–4 supremis incompletis, reliquis bipaleaceis, hermaphroditis, rhachillæ articulis brevibus, compressis, vix hirsutis, glumis 1–2 inferioribus gemmiparis. *Palea* inferior nervosa, nervis utrinque 3–5 validis cum totidem internediis tenuioribus, dorso vel glabra vel inconspicue hirsuta, apice rotundata et mucronata; superior brevior, margine fimbriata, inter carinas brevissime alatas 3-nervosa. *Squamulæ* 3, oblongo-lanceolatæ, 2 latiores. *Stylus* basi subbulbosus, attenuatus, superne in stigmata 3 longa divisus. *Ovarium* subobovatum, apice hirsutum, in stylum attenuatum.

The structure of the spicula in this species is very similar to that of *G. Venezuelæ*; but the branches of the panicle, bent back nearly to the main axis, give the plant a very peculiar and distinctive appearance. In Gardner's specimen the panicle is not expanded, and the branches are still covered with their enveloping sheaths; but I have little doubt of its identity. Some of Burchell's specimens, carefully marked, however, with the same number, are extremely hairy, and the cilia are placed at the end of a long linear auricle instead of simply at the mouth of the vaginæ; but after a careful examination I see no reason to doubt the correctness of Burchell's identification.

12. G. PANICULATA, Munro. Culmo florifero aphyllo, paniculæ ramis divaricatis, valde inæqualibus, compositis et decompositis, latere *uno planis* et pilis *canescentibus hirsutis*, spiculis *cylindricis*, angustis, 6–9 lin. longis, palea inferiore nervosa, dorso *subglabra*, margine fimbriata, foliis 4–7 poll. longis, 2½–5 lin. latis, petiolis hirsutis, vaginis plerumque glabris, margine non ciliatis.

Hab. in Brasilia tropica, prov. Goyaz ad flum. Tocantins, in sylvis, *Burchell*, no. 8852!; prov. Pernambuco, Rio Preto, in sylvis ("Taboca" incolis), *Gardner*, no. 2981! v. s.

Culmus 20–30-pedalis, diametro 1½ poll., foliiferi internodiis superioribus 1–1½ poll. longis, subglabris vel pubescentibus, ramulis ½–1-pedalibus, paucis ad nodos fasciculatis. *Folia* lineari-lanceolata, 4–6–7 poll. longa, 2–5 lin. lata, basi attenuata in petiolum brevem præcipue subtus pilosum, apice interdum nigrescente *attenuato-acuminatissima*, supra scabra et interdum pilis brevissimis hirsutiuscula, subtus vel glabra vel, præcipue basin versus ad costam, brevissime pilosa, nervis secundariis utrinque 4–5, margine subscabra. *Vaginæ* plerumque glabræ, margine non ciliatæ, ore ciliis paucis *scabris* fimbriatæ, eligulatæ. *Inflorescentia*, in culmo aphyllo, expansa, paniculata, ramosissima, 10-pedalis, ramis 2–3 valde inæqualibus, divaricatis, *adscendentibus*, per intervalla 2–4-pollicaria ad nodos locatis. Hi rami, 6–9 poll. longi, plus minus compositi, ramulos vel spiculas paucas glomeratas ad

nodos ferunt. *Spicula* angusta, cylindrica, sæpe curvata, 5–8 lin. longa, pauciflora, flosculis 1–2 inferioribus et 1–2 superioribus incompletis, reliquis hermaphroditis, glumis glabris, coloratis, interdum gemmiparis. *Palea* inferior nervis validis 6–10 cum totidem intermediis tenuioribus, dorso subglabra, margine fimbriata; superiore margine ciliata et brevialata, sæpe conspicue *brevior*. *Squamulæ, stylus* et *ovarium* veluti in *G. refracta*.

In many respects this approaches *G. refracta*; but the spiculæ are more deeply coloured, shorter, narrower, and with fewer flowers; and the panicle, of which there is an excellent specimen in Burchell's collection, is much more compound, with the divergent branches inclining upwards. The leaves are occasionally nearly as long as in *G. refracta*, but they are much more attenuated at the points, and generally very much narrower.

13. G. Venezuelæ, Munro. Culmo florifero aphyllo, paniculæ ramis divaricatis, decompositis, latere uno planis hirsutis, spiculis compressis, 9–12 lin. longis, palea inferiore *nervoso-costata*, dorso *hirsuta*, foliis plerumque 3–4½ poll. longis, 4–5 lin. latis, petiolis hirsutissimis, vaginis glabris vel superne hirsutis, uno margine *longe* ciliatis.

Hab. in Venezuela, *Dr. Krueger*! v. s.

Culmus fistulosus, viridis, striatus, foliiferi internodiis superioribus sub 3-pollicaribus, uno latere planis, canaliculatis, hirsutis, nodis undique strigoso-hispidis, ramulis paucis brevibus ad nodos fasciculatis. *Folia* lanceolata 1½–4½ poll. longa, 4–5–2 lin. lata, acuta, basi subrotundata, vix attenuata in petiolum brevem complanatum, utrinque (sed subtus præcipue) pilis longis hirsutissimum, supra scabra, subtus pilis brevibus hirsuta vel demum glabrescentia, nervis secundariis utroque latere 3–4 conspicuis, margine brevissime serrata. *Vaginæ* inferiores hirsutæ, superiores vel glabræ vel superne hirsutæ, uno margine longe ciliatæ, oreque ciliis longis paucis sat rigidis caducis fimbriatæ, vix ligulatæ.

Culmi floriferi paniculæ ramus unus longus tantum adest, adjectis plurimis brevissimis simplicibus ad nodum strigoso-hirsutum fasciculatis. *Ramus* subsesquipedalis, internodiis 2–3 poll. longis, rhachi strigoso-hispida, ramulos 2–3 valde inæquales ad nodos strigosos gerens. *Spiculæ* pallidæ, 2–3, glomeratæ, 5–6–8 floræ, basi valde attenuatæ, 9–12 lin. longæ, rhachillæ articulis brevibus, hirsutis, flosculis 2–3 terminalibus incompletis, glumis interdum gemmiparis. *Palea* inferior extus hirsuta, nervoso-costata, apice mucronata; superior obtusa, carinata, inter carinas alatas et longe ciliatas 3–4-nervia, inferiorem æquans vel superans. *Squamulæ, stylus* et *ovarium* veluti in *G. refracta* et *G. paniculata*.

The specimens which I have seen of this are very imperfect; but I think it is readily distinguishable from *G. refracta* by its much smaller leaves and the long fringe on one side of the vagina. The single branch of the panicle which I have seen is also very much more compound, and the spiculæ more hirsute, than in either of the two preceding species.

All these last three species are certainly very closely allied, especially in the structure of the spiculæ, although they are remarkably different in general appearance. They have all the same obovate form of ovary that is found in *Bambusa tulda* and allied species; and the keels of the upper palea are very much less winged than in any of the ten other species of *Guadua*. Consequently there remains but little except their geographical distribution and their peculiar hairy petioles to separate them from the genus *Bambusa*, in

which genus I should have been inclined to include them had they been dwellers in the East instead of the West.

GUADUA PARVIFLORA, Presl in Reliq. Hænk.=*Arthrostylidium maculatum*, Rupr.

XI. BAMBUSA.

Schreber, Gen. Plan. no. 607 (1789); Roxburgh (1795). *Arundarbor*, Casp. Bauhin (1671); Rumph. Herb. Amboin. iv. 5 (1750). *Arundo*, sp., Linn. et Lour. *Bambos*, Retz. *Obs.* v. 24 (1789); Pers. Syn. (1805).

Spicula multiflora vel raro pauciflora, *sursum deorsumque imperfecta*, vel cylindrica, elongata, rhachilla plus minus conspicua, vel ovata aut oblonga, rhachilla abscondita, interdum fere obsoleta, plerumque sessilis, raro glumis distantibus, quasi pedicellata. *Glumæ* duæ aut numero indefinitæ, inferiores plerumque gemmiparæ et breves, superiores paleis inferioribus flosculorum similes et pro flosculis habendæ, sæpe plurinerves. *Palea* inferior plurinervis, mutica aut mucronata, plerumque glabra, coriaceo-chartacea; superior membranacea, angustior, vel subæquilonga vel longior, bicarinata carinis *non alatis* sed sæpe conspicue fimbriatis. *Squamulæ* typice 3, plerumque obtusæ, ciliatæ, membranaceæ, raro abortu 1–2 deficientes. *Stamina* 6, *basi libera*, antheris vel obtusis vel *apiculatis* vel apice *penicillatis*. *Stylus* in sectione prima brevis, cito et sæpe fere *ad basin* 3-*fidus*, in secunda ad basin *subbulbosus*, non tam profunde 2–3-fidus, in tertia longus, basi simplex, *superne tantum* in stigmata 2–3 secedens. *Stigmata* vel brevia plumosa, vel longa et pilosa. *Ovarium* vel obovatum, apice hirsutum, vel lineari-oblongum, vel rostratum. *Caryopsis* oblonga vel lineari-oblonga, obtusa aut acuta, sulco longitudinali conspicue notata, palea superiore plerumque arcte inclusa. Gramina arborescentia, vel pauca suffruticosa, interdum scandentia. Species unica (*B. vulgaris*) cosmopolitana, reliquæ omnes orbis antiqui orientalis incolæ. *Culmus* sæpe altissimus, usque ad 120-pedalis, e nodis ramos sæpe ramosissimos emittens, interdum spinosus, ramis junioribus sæpe pungentibus. *Folia* varia, angusta vel lata, venulis transversis vel nullis vel conspicuis, vaginis plerumque ore fimbriatis. *Inflorescentia* vel "scapus radicalis," vel panicula, in culmo inferne foliis denudato, interdum ramosissima et quam maxime decomposita, ramis simpliciter vel composite spicatis, sæpe laxiusculis, adjectis interdum ramulis foliiferis quorum folia minora sunt reliquis, spiculis sæpissime semiverticillato-spicatis. In *B. nana* et paucis aliis, panicula sæpe in ramulis (basi foliatis) terminalis, fere simplex et interdum valde depauperata.

I have already, at p. 76, mentioned how very little *Bambusa* differs as a genus from *Guadua*. I have not included any species in *Bambusa* in which the filaments are monadelphous, but have placed them in one or other of the two following genera. It appears to me that the united filamental tube of these two genera indicates an interesting transition between the true Bamboos and the berry-bearing ones, in which the peculiar envelope enclosing the real fruit, which I have already referred to at page 4, may possibly prove to be an interior staminodium, or series of stamens of which the tube only is perfected. This envelope, in its youngest state, is very soft and impressive; for I have often observed it bear the impression of the vascular bundles of the true filaments.

Conspectus Specierum.

Sect. I. Stylus brevis, cito fere ad basin 3-fidus, vel (in *B. balcooa*) ad vel paulo infra medium 3-fidus. stigmatibus plerumque brevibus, plumosis.

Culmus *inermis*. Ovarium *obovatum*. Spicula *cylindrica, elongata*.

Folia plerumque *angusta* et subtus discoloria, *venulis transversis nullis*.

Culmus *suffruticosus*. Panicula sæpe *depauperata* et *basi foliosa*, spiculis interdum solitariis, palea *superiore* carinis *glaberrima* . 1. *B. nana*.

Culmus *arboreus, elatus, cavus*. Panicula decomposita, vasta, basi nuda, rhachi *tereti nitida*, spiculis coriaceis, *nitidis, plurimis fertilibus, laxe* verticillatis, 1–3 poll. longis, antheris *obtusis* . . 2. *B. tulda*.

Culmus *vix* arboreus, *gracilis, subsolidus*. Panicula ut in *B. tulda*, sed minor, spiculis *plurimis sterilibus, dense* verticillatis, 10–14 lin. longis, antheris apiculatis . . . . . 3. *B. nutans*.

Culmus *subscandens*. Folia *longe petiolata*, vaginis *ore nudis*. Panicula composita, *basi foliata* (an semper?), spiculis coriaceis, nitidis, palea inferiore *longe acuminata* . . . . . 4. *B. affinis*.

Culmus *vix* arboreus. Panicula composita, rhachi *nitida*, glabra, dura, *ramis subsimplicibus*, spiculis *membranaceis*, subcompressis, 12–14 lin. longis, palea inferiore apice *subobtuso* mucronata . . . 5. *B. tuldoides*.

Culmus *suffruticosus*? Panicula decomposita, rhachi *molli, striata, submedullacea*, ramis *angulatis*, spiculis *membranaceis, pallidis*, 6–12 lin. longis . . . . . 6. *B. angulata*.

Folia *lata, venulis transversis conspicuis*.

Folia *basi attenuata*, $1\frac{1}{2}$–$1\frac{3}{4}$ poll. lata, ligula *brevi*. Panicula composita, rhachi *cava, fistulosa*, spiculis fertilibus $1\frac{1}{2}$–2 poll. longis, antheris apice *penicillatis* . . . . . 7. *B. teres*.

Folia *basi rotundata*, $2\frac{1}{2}$–$3\frac{1}{2}$ poll. lata, ligula *elongata*. Panicula decomposita, spiculis (*plurimis sterilibus*) 10–12 lin. longis, pallidis, antheris apice *penicillatis* . . . . . 8. *B. Falconeri*.

Culmus inermis. Ovarium *subobovatum*. Spicula *brevis, pauciflora*.

Folia *basi rotundata*, 2–3 poll. longa, vaginis utrinque auriculatis. Panicula vix composita, rhachi dura, subsolida, spicula 6 lin. longa, flosculis 2–3 perfectis, his palea superiore inferiorem obtusam sæpe superante . . . . . 9. *B. breviflora*.

Culmus inermis. Ovarium rostratum. Stylus fere ad rostrum 3-fidus, stigmatibus subtenuibus. Spicula vel elongata vel brevis, flosculis hermaphroditis plerumque, nisi forsan in *B. balcooa*, paucis.

Culmus arboreus, fistulosus. Folia 4–8 poll. longa, 5–7 lin. lata, *subtus hirsuta*. Spicula cylindrica, pallida, fertilis 12–14 lin. longa, flosculis 3–4 hermaphroditis, antheris seta apiculatis . . . 10. *B. pallida*.

Culmus fistulosus, vix arboreus. Folia 4–6–8 poll. longa, 9–12–18 lin. lata, *utrinque glabra*. Spicula cylindrica, 7–9 lin. longa, flosculis 2–3 hermaphroditis, antheris obtusis. Ovarii rostro *glabro* . . 11. *B. Khasiana*.

Culmus elatus, arboreus. Folia *tenuia*, 4–6 poll. longa, 5–7 lin. lata, subtus *hirsuta*. Spicula cylindrica, sub 6 lin. longa, flosculis 2–3 perfectis, terminali tabescente longe pedicellato, palea superiore carinis *subglabra*. Ovarii rostro *hirsuto* . . . . . 12. *B. polymorpha*.

Culmus *subscandens*. Folia *magna*, 12–18 poll. longa, 2–$2\frac{3}{4}$ poll. lata, valde discoloria. Spicula cylindrica, 6 lin. longa, flosculo *nonnisi penultimo* hermaphrodito, terminali pedicellato, palea superiore carinis *glabra* . . . . . 13. *B. Griffithiana*.

Culmus *arboreus, fistulosus*. Folia subpedalia, 1–2 poll. lata. Spicula *ovata* vel *oblonga, mollis*, flosculis 4–6 hermaphroditis, palea superiore carinis *longe ciliata*. Stylus ad vel *paullo infra medium* 3-fidus . 14. *B. balcooa*.

Culmus spinosus. Ovarium rostratum. Caryopsis basi styli trifidi coronata, subtricornuta.

Culmus *suffruticosus*, nanus. Folia *parva*, vix 2 poll. longa. Spicula 8–12-flora, rhachilla valde conspicua, *flexuosa*, paleis *hiantibus*, inferiore *rostrato-acuminata* . . . . . 15. *B. flexuosa.*

Culmus *elongatus*, vix *arboreus*. Folia 3–6 poll. longa. Spicula sub 8-flora, rhachilla tandem *conspicua*, paleis imbricatis, inferiore mucronato-acuta . . . . . 16. *B. Blumeana.*

Sect. II. Stylus basi subbulbosus, profunde (sed non ad basin) 2–3-fidus, stigmatibus longis, tenuibus. Ovarium infra apicem constrictum. Caryopsis conico-rostrato-acuta. Palea superior in flosculis perfectis inferiorem plerumque superans.

Culmus *spinosus*. Paniculæ rhachis teres, *glaberrima, nitida, dura*, glomerulis plerumque *paucispiculatis*. Spicula 8–12 lin. longa, 6–12-flora, flosculis fertilibus 3–7 . . . . . 17. *B. arundinacea.*

Culmus *spinosus*. Paniculæ rhachis teres, *striata, vix nitida, dura*, spiculis plerumque *dense glomerato-verticillatis*. Spicula coriacea, sæpe monoica, 5–6 lin. longa, 4–6-flora, flosculis fertilibus 2–3 . 18. *B. spinosa.*

Culmus *inermis*? Paniculæ rhachis *glauco-viridis, angulata, submollis*. Spicula *submembranacea*, 7–9 lin. longa, 5–8-flora, flosculis fertilibus 3–5 . . . . . 19. *B. orientalis.*

Sect. III. Stylus longus, basi simplex, hirsutus, superne tantum (vel, in *B. Oldhami*, ad medium) 2–3-fidus. Culmus inermis.

Culmus *arboreus*. Spicula *oblonga, subcompressa*, evoluta *quasi bifida*. Palea inferior *basi subattenuata*, superne margine *fimbriata*. Antheræ *pilis brevibus* apiculatæ. Squamulæ 3 . . . . 20. *B. vulgaris.*

Culmus *subarboreus*. Panicula *composita*. Spicula ovata vel ovato-lanceolata, 7–8 lin. longa, flosculis 7–11, palea inferiore basi *latissima*. Squamulæ 3 . . . . . 21. *B. Beecheyana.*

Culmus eximie *fistulosus, cavus, suffruticosus*? Panicula *subsimplex*. Spicula *ovato-lanceolata*, 12–13 lin. longa, flosculis 8–13, palea inferiore basi latissima. Squamulæ 2–3. Stylus sæpe ad medium 3-fidus 22. *B. Oldhami.*

Culmus *arboreus*, maximus. Spicula *ovata, brevissima*, 3–4 lin. longa. Palea inferior spinoso-acuta, margine *longe fimbriata*. Squamulæ 1–2–3 . . . . . 23. *B. Brandisii.*

1. B. NANA, Roxb. Hort. Beng. 25 (1814); Fl. Ind. ii. 199. Panicula interdum depauperata, in ramulis sæpe efoliatis paucispiculata, ramulis foliiferis adjectis, interdum subsimplici et etiam monostachya, ramulis foliiferis terminali, raro composita, spiculis cylindricis, perfectis 1–1½ poll. longis, palea superiore *margine glaberrima*, staminibus 6, quorum 3 interdum (lusu) obsoletis, foliis plerumque parvis, 1–3-pollicaribus, interdum majoribus, 3–5 poll. longis, subtus *cæsio-glaucis*, vaginis ore subauriculato-fimbriatis.—*B. nana*, hb. Ham. in Wall. Cat. 5036! *B. glauca*, Loddig. Cat. et Lindl. in Penny Cyc. (1835); Rœm. et Sch. *l. c.* vii. 1355; Blume. *B. floribunda*, Zoll., Steud. in Zoll. Cat. 57; Syn. 330; Miquel, Ann. Mus. Bot. Lug.-Bat. ii. 285, teste Kurz in herb. ex hort. Bogor. *B. cæsia*, Sieb. et Zucc. fide spec. in herb. Kew ex herb. Zucc. *B. glaucescens*, Sieb. Cat. et Hort. *B. sterilis*, Kurz in Hort.

Bogor. fide Miq. *l. c.* (var. foliis supremis valde deminutis ramulisque pluribus efoliatis). *Iscurochloa floribunda*, Büse, in Pl. Jungh. 390; Miq. Fl. Ind. Bat. iii. 422. *Arundinaria glaucescens*, P. de B. Agros. 144, et supra, p. 22, cum syn. omnibus. Ludit glumis et etiam paleis inferioribus flosculorum inferiorum in folia conversis, stylo 2–4-fido, staminibus 3, vel etiam 6, obsoletis, filamentis basi squamulæformibus.

Hab. in China ("Keu-fa" incolis), *Roxburgh*; in Japonia, *Buerger*; ins. Niphon in sylvis montanis prope Susokatogi, *Pierrot*. Cult. in hortis Ind. or. Dacca et Calcutta, *Hamilton*! *Roxburgh, Hooker*!; in hort. Ceylon, status abnormalis, staminibus 3–6 plus minus obsoletis, sub nom. "Chinese Bamboo," *Thwaites*!; in hort. Java, *Blume, Kurz*!; in hortis Europæ plurimis. ("Tsiutsik" vel "Tsiuts Take," Jap.) **v. v. et s.**

Culmus suffruticosus, inermis, fistulosus, 6–8-pedalis, diametro $1\frac{1}{2}$-lineali; spathis (in culmis junioribus) $1\frac{1}{2}$ poll. longis, glaberrimis, striatis, intus nitidis, apiculo lanceolato basi biauriculato semipollicari. *Rami* simplices vel compositi, ad nodos inferiores numerosissimi, ad superiores 2–4–8 semiverticillati, internodiis superne glabris vel scabriusculis vel pruinoso-glaucis. *Folia* plerumque parva, lanceolata, 1–$2\frac{1}{2}$ poll. longa, 2–5 lin. lata, interdum majora, 3–5 poll. longa, apice acutissima, basi subcordato-rotundata, petiolo glabro flavescente, subtus pulchre *cæsio-glauca*, pilis brevissimis pubescentia vel demum glabrescentia, nervis secundariis subconspicuis, utroque latere 3–5. *Vaginæ* glabræ, striatæ, ore biappendiculatæ, fimbriatæ vel demum nudæ. *Inflorescentia* nunc panicula depauperata, spiculis in spica remotiflora dissite sparsis, ramo, foliis cito delapsis, basi nudo *terminali*; nunc spicula solitaria paucæve, ramulis dense foliiferis terminales; raro (in spec. e Ceylon) panicula composita (an culmo terminalis?), subaphylla, internodiis 4–6 poll. longis, spiculis in glomerulis per ramos breves, simplices vel compositos, semiverticillatos dissite sparsis, paucis, inæqualibus. *Spicula* primum cylindrica, demum subcompressa, 7–11-flora, glabra, rhachillæ articulis conspicuis, elongatis, sulcatis, superne tantum hirsutis, glumis sæpe gemmiparis et interdum, in spiculis solitariis, apice in laminam foliaceam expansis, flosculis 1–2 inferioribus et 2–3 superioribus incompletis (vel masculis vel femineis), intermediis 3–6 hermaphroditis. *Palea* inferior 14–18-nervis, vix acuta, glaberrima, superiorem multinervosam, *carinis glabram*, apice tantum subhirsutam involvens et superans. *Squamulæ* typice 3, lanceolatæ, elongatæ, basi interdum callosæ et inconspicue nervosæ. *Stamina* typice 6, antherarum connectivis nunc obtusis nunc seta apiculatis. *Stylus* cito 3-fidus, stigmatibus pulchre plumosis. *Ovarium* stipitatum, obovatum, superne hirsutum.

In statu luso e Ceylon, a Thwaites mihi misso, stamina 1–3 tantum perfecta, tria plus minus obsoleta; hæc nunc squamularum formam arrogant, nunc ad rudimenta brevissima, squamulis normalibus adhærentia, redacta. Stylus sæpe abnormalis, nunc indivisus, nunc bifidus, cruribus 1–2 iterum divisis, et hinc stigmatibus 4, nunc trifidus. In flosculis nonnullis 2–3 ovaria adsunt.

Whilst these pages were passing through the press, I received some flowering specimens of this plant from Mr. Thwaites, which have enabled me to ascertain that the opinions which I have long entertained, as stated above at p. 22, regarding the identity of *B. nana* and *Arundinaria glaucescens*, are correct. Some of Mr. Thwaites's specimens are evidently in the same condition as those seen and figured by Ruprecht in fig. 3. tab. i. of his memoir on Bambusæ, the three abortive stamens apparently being figured as 3 ovaries. The rudiments of these stamens are certainly sometimes extremely minute, although occasionally they are nearly half as long as, and very similar to, the squamulæ. In all the flowers which I have examined, I have been able, after careful maceration, to discover the vascular bundles of the filaments. Thwaites says, in a note attached to the specimen,

"Flowers usually imperfect; I can see no ripe seeds forming." In all the other specimens which I have seen from Buitenzorg and Kew (where the plants flowered in October 1862), the 6 stamina are quite perfect, and the spicula is regular in all respects. It is very closely allied to *B. tulda*. I have observed in the living plants that the terminal leaf of the branch is not as glaucous as the remainder of the leaves on the same branch.

2. B. TULDA, Roxb. Hort. Beng. 25 (1814); Fl. Ind. ii. 193, Icon. 1403! et herb. Roxb.! Culmo inermi, fistuloso, *excelso*, florifero basi aphyllo, sed ramulis ultimis floriferis sæpe basi foliatis; panicula ampla, decomposita, rhachi nitida *glaberrima*, ramis simplicibus vel compositis, divaricatis; spiculis in verticillis simplicibus vel compositis per ramulos ultimos sparsis, interdum solitariis, lanceolatis, *plurimis fertilibus*, 1–3 poll. longis, multifloris, *nitidis*, articulis rhachillæ conspicuæ longis, apice *fimbriatis*; palea inferiore acuta, margine superne sæpe brevifimbriata, superiore carinis *longe ciliata*; antheris *obtusis*, ovario *obovato*, apice *hirsuto*; foliis lineari-lanceolatis, 4–12 poll. longis, 6–12 lin. latis, subtus plerumque *hirsutis*, *petiolo* supra *hirsuto*.—*B. trigyna*, Roxb. MS. herb. Mus. Brit.! *B. macala*, hb. Ham.

Hab. in Ind. or. Bengal ("Tulda Bans" incolis), *Roxburgh*! 5030 c.! *Wallich*, *Griffith*!; Birgung, 880 bis! (folia tantum); Takurgung, 880! *hb. Hamilton*, *Wall. Cat.* 5026 A; Assam? Seebsagur, 944! *Masters*; Tenasserim, Martaban, Meaong! Trogla! 5027! *Wallich*; var. ramulis floriferis basi foliatis ("Jowa Bans"), Bengal, Serampore! Hort. Bot. Cat. ! *Griffith*, *herb. Roxb.*! *in Wall. Cat.* 5030 B! *et in herb. Mus. Brit.*!; Cachar ("Dullooah")! *Hooker*. v. s.

Culmus arboreus, elatus, gregarius, inermis, fistulosus (parietibus tenuibus), "diebus 30 altitudinem 20–70-pedalem, cum diametro 2–4-pollicari, attingens" (Roxb.), spathis coriaceis cito deciduis, ramis numerosissimis, ultimis bifariis. *Folia* lineari-lanceolata, acuta, basi rotundata vel cordata vel raro attenuata, petiolo brevi, plano, supra hirsuto, 4–6–12 poll. longa, 8–12 lin. lata, supra tactu scabra, subtus pallidiora et plerumque hirsuta, raro glabra, nervis secundariis utrinque 5–6, inconspicuis. *Vaginæ* superne, interdum pilis longis, hirsutæ, margine uno ciliatæ, utroque latere auriculatis, auriculis interdum elongatis et longe ciliatis, ligula brevi. *Panicula* vasta, decomposita, oblonga, undulata, ramis ramulisque numerosis supra decompositis, ramulis ultimis, ad nodos, spiculas vel solitarias vel 2–3-nas vel laxe glomeratas gerentibus, foliis non raro inflorescentiam intrantibus, axillis interdum spiculam elongatam 3-pollicarem ferentibus. *Spicula* nitida, plerumque fertilis, cylindrica, lanceolata, 9–36 lin. longa, 7–10–12-flora, rhachillæ conspicuæ articulis longis, compressis, apice tantum hirsutis, glumis inferioribus gemmiparis. *Palea* inferior lævissima, nitida, acuminata, basi submembranacea et plicata, interdum 12 lin. longa, multinervis, margine interdum brevissime fimbriata; superior subbrevior vel fere æquilonga, inter carinas longe ciliatas 3–5-nervis, apice pilis penicillata. *Squamulæ* longe vel longissime fimbriatæ, basi sæpe coloratæ et conspicuæ nervosæ, duæ obtusæ, tertia lanceolata. *Antheræ* "rubro-purpureæ," muticæ vel brevissime obtusiapiculatæ. *Stylus* cito divisus in stigmata 3 plumosa. *Ovarium* obovatum, apice hirsutum, stipitatum. *Caryopsis* oblonga vel ovalis, apice obtuso hirsuta.

This species, unless the following, *P. nutans*, should prove to be a mountain form of it, appears to be principally confined to the plains of Bengal and the nearly adjoining provinces; but I am unable to distinguish specifically the specimens collected by Wallich in 1827 in the teak-forests of Martaban, and contained in his herbarium No. 5027. The section, however, of the stem which is attached to these specimens is much more solid

than is usual in *B. tulda*. Arnott, in his MS. notes on Hamilton's grasses, says that 880 hb. Ham., Wall. 5026 A, is "*Beesha Rheedei*;" but that is certainly not the case in the specimens of that number in Wallich's herbarium in the possession of the Linnean Society. Some of the specimens of this species from Calcutta are marked "*B. stricta*," and some "*B. latifolia*."

3. B. NUTANS, Wallich, MS. in herb. 5031! Culmo inermi, *subsolido*, *gracili*, vix arboreo, florifero, interdum aphyllo, interdum ramis foliiferis floriferisque ex eodem nodo erumpentibus; panicula nutante, composita, rhachi *nitida*, *glaberrima*, ramis plerumque *brevibus*, *erectis*, sæpe *a basi* dense *spicatis*; spiculis *dimorphis*, in verticillis *approximatis* dense glomeratis, *plurimis sterilibus*, gemmiparis, sub 10 lin. longis, acutis, rhachillæ articulis brevibus, subhirsutis, *paucis fertilibus*, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longis, rhachillæ articulis longis, subglabris; palea inferiore (spiculæ fertilis) longe acuminata, sæpe 1 poll. longa, antherarum connectivo elongato; foliis plerumque 4–7 poll. longis, discoloribus, subtus pilosis et sæpe canescentibus, vaginis plerumque *glabris*, margine *efimbriatis*.

Hab. in Ind. or. Nepal, Nag-Arjoon, *Wallich*, *Cat.* 5031! Silhet ("Peechle Bans"), *Da Costa in Wall. Cat.* 5030 A! spiculis fertilibus evolutis; Khasia, no. 316 *in Kew Mus.*! *Griffith*, spiculis fere omnibus sterilibus, foliis subtus canescentibus; Assam, Seebsagar ("Bidhooli Bans"), no. 945! ("Mukial Bans") no. 946! *Masters* (folia tantum); Sikkim? Pemionchi! alt. 5000–7000 ped. s. m. ("Mahlo" incolis), *Thomson* (folia), var. foliis latioribus et culmo fistuloso. v. s.

Culmus vix arboreus, foliiferus, subsolidus, in spec. a me visis gracilis, $1\frac{1}{2}$ lin. diametro, internodiis 4 poll. longis, ramis sæpe simplicibus, semiverticillatis, adjectis interdum, in spec. e Khasia, ramis floriferis aphyllis. *Folia* vix petiolata, lineari-lanceolata, apice attenuato-acuta, basi rotundata vel cuneata, 4–7 vel raro 9 poll. longa, 6–9 (raro 12–15) lin. lata, supra subfusca, uno latere marginibusque tactu scabra, subtus pallida vel canescentia, pilosa vel raro glabra, nervis secundariis utroque latere 4–6–9. *Vaginæ* plerumque glabræ, dorso carinatæ, margine *nunquam ciliatæ*, collo *biauriculatæ*, auriculis interdum *elongatis*, ciliis non raro 9 lin. longis, fimbriatis, ligula subelongata, obtusa, dorso hirsuta. *Panicula*, in culmo florifero, vix expansa (pars superior 10-pedalis, internodiis 5–6 poll. longis, adest), ramis validis, suberectis, plerumque brevibus et simplicibus, sæpe ex *ima basi* floriferis, verticillis densis, approximatis, spiculis *plerisque* gemmiparis, *sterilibus*, acutissimis, 10–12 lin. longis, rhachillæ conditæ articulis subhirsutis, apice fimbriatis, flosculis sæpe bipalcaceis sed imperfectis. *Spicula fertilis* $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, nitida, 7–9-flora, flosculis hermaphroditis 3–5, rhachillæ conspicuæ articulis longis, glabris vel apice fimbriatis, palea inferiore *longissime acuminata*, interdum 1 poll. longa, margine subglabra, intus hirsutiuscula, superiorem carinis ciliatam superante. *Squamulæ* obtusæ, latæ, longe ciliatæ, multinerves, subæquales. *Stamina* 6 vel rarissime 7!, connectivo elongato. *Ovarium* obovatum, stipitatum. *Caryopsis* oblonga, apice obtuso hirsuta.

This may possibly be a mountain form of *B. tulda*; but it appears to me to be a much smaller plant, with a slender and nearly solid stem. The ligula is more extended, the leaves generally whiter below, and the vaginæ are never fringed on the margin; the paucity of fertile spiculæ is also remarkable. Griffith's herbarium contains a large number of specimens; but I have scarcely been able to find a dozen perfect spiculæ amongst them. Wall. Cat. 5030 A exhibits a very perfect developed state; 5030 B & C are ordinary forms of *B. tulda*. Thomson says that bows are made in Sikkim from the

"Mah-lo" bamboo. Some specimens, under the same native name, collected by Hooker in Sikkim, appear to me to be quite distinct; and I think there is considerable doubt about the identity of Thomson's specimens, which are in leaf only.

4. B. AFFINIS, Munro. Culmo florifero *foliato*? diffuso, *scandente*, paniculæ *coloratæ* ramis elongatis, erectis, ad nodos paucis, spiculis *coriaceis*, *coloratis*, palea inferiore *longe acuminata*, foliis *petiolatis*, fere setaceo-acuminatis, vaginis ore *efimbriatis*, conspicue ligulatis.

Hab. in Ind. or. Burmah; Yoongalum ("Theeshe" incolis), no. 18, *Brandis*! v. s.

"*Culmus* diffusus, *scandens*, diametro vix bipollicari," ramulis foliiferis 1–1½-pedalibus, semper in specimine visis apice floriferis. *Folia* lanceolata, 4–8 poll. longa, 10–12 lin. lata, demum refracta, basi rotundata, conspicue *petiolata*, apice fere *setaceo-acuminata*, margine brevissime serrata, utrinque *glabra*, subtus pallidiora, nervis secundariis utroque latere 8–10 vel interdum 5 (teste Brandis). *Vaginæ* striatæ, glaberrimæ, infra petiolum membrana integra coriacea terminatæ, ore *non-fimbriatæ*, ligula *producta*, obtusissima. *Panicula* in culmo foliifero terminalis, an semper?, internodiis glaberrimis, 4–7 poll. longis, ramulis ad internodia 2–3, sæpe pedalibus et ultra, spiculas paucas, coriaceas, nitidas, subpollicares, semiverticillatas, per intervalla 2–4 poll. distantes, gerentibus. Interdum spica, fere simplex, in ramulis foliiferis terminalis. *Spicula coriacea*, 6–10-flora, *nitidissima*, læte fusca, rhachillæ articulis striatis, subbrevibus, apice brevissime fimbriatis. *Palea* inferior plus quam 20-nervis, basi plicata, apice *longe acuminata*; superior multo angustior, inter carinas ciliatas 7-nervis, et extus carinas utrinque 4-nervis. *Squamulæ* 3, fere crassæ, basi nervosæ et subplicatæ, duæ majores basi interdum coalitæ. *Ovarium* subobovatum, apice obtuso subhirsutum et attenuatum in stylum, cito in stigmata 3 divisum.

This, again, approaches very closely to *B. tulda*; but the scandent habit would appear to keep it distinct, as well as the long petioles, and vaginæ without any traces of a fringe, but with a ligule of some length. The specimens are not sufficiently perfect to show whether the leaf-bearing and flowering culms are ever distinct; but that is not likely to be the case in a climbing plant.

5. B. TULDOIDES, Munro. Culmo inermi, vix arboreo, fistuloso; paniculæ ramis inferioribus subsimplicibus, semiverticillatis, paucis, superioribus alternis, foliis superne inflorescentiam intrantibus, rhachi nitida, glabra, dura, tereti; spiculis pallidis, *non nitidis*, *membranaceis*, cylindrico-compressis, subuncialibus, rhachilla tandem visibili, in glomerulis, plus minus distantibus, vix dense aggregatis, palea inferiore apice *subobtusa*, *subito mucronata*; foliis *angustis*, subtus pallidis et hirsutis, vaginis glabris.—*B. Blumeana*? Hook. et Arn. Bot. Beechey's Voyage, 254, ad not., non Rœm. et Sch. *B. tulda*, Benth. Fl. Hongk. 434, non Roxb.

Hab. in China, Canton, *Millett*!; Hongkong, 3657! 7486! *Hance*; Formosa, 652! *Oldham*. v. s.

Culmus subarboreus?, inermis, subsolidus vel fistulosus. (Ramuli foliiferi, internodiis sulcato-striatis, duo tantum adsunt) hæc folia 5–7 poll. longa, 5–8 lin. lata, lanceolata, basi rotundata, petiolata, margine (præcipue basin versus) longe serrata, supra glabra vel margine tactu scabra, subtus hirsuta, nervis secundariis utrinque 6–8, subconspicuis. *Vaginæ* glabræ, pulchre striatæ, auriculis ciliis paucis caducis fimbriatis biauriculatæ. *Folia* floralia similia, sed minora, basi attenuata, nervis secundariis paucioribus, auriculis vaginæ obsoletis. *Panicula* diametro inferne 3 lin., rhachi glabra,

ramis simplicibus vel compositis, valde inæqualibus, ad nodos inferiores 5–6, ad superiores 1–3, sub semiverticillatis, *internodiis* infimis *apice scabriusculis*, glomerulis plerumque paucispiculatis, raro subdensifloris, approximatis vel distantibus. *Spicula* pallida, *membranacea*, non nitida, interdum tortuosa, rhachillæ (tandem conspicuæ) articulis inferioribus brevibus, apice tantum hirsutis, 12–14 lin. longa, 4–8-flora, flosculo infimo masculo, 2–5 sequentibus fertilibus, 1–2 supremis tabescentibus. *Palea* inferior nervosa, glabra, obtusa, brevimucronata; superior vix vel multo brevior, acuminata, apice fasciculo pilorum terminata, carinis *superne tantum* breviciliatis. *Squamulæ* obovatæ, obtusissimæ, longe et tenuissime fimbriatæ. *Antheræ* obtusæ. *Stylus* cito 3-fidus in stigmata 3 sublonga et tenuia. *Ovarium* stipitatum, fere obovatum, apice hirsutum, in stylum rostratum. *Caryopsis* $2\frac{1}{2}$ lin. longa, obtusa, fere glabra.

In the structure of the spicula this is very close to *B. tulda*; but the plant appears to be smaller, and to have a generally different appearance. Moreover Mr. Hance, who has had an opportunity of observing the plant when growing, is decidedly of opinion that it is distinct. The perfect spicules are much smaller than in *B. tulda*, and have not the usual shining appearance; the lower palea is blunter and has fewer nerves; the vaginæ are more glabrous and more deeply striated; and I have never observed the lowest branches near the main axis to be scabrous in *tulda*, as they often are in this species.

6. B. ANGULATA, Munro. Culmo inermi, *herbaceo*?, fistuloso, paniculæ rhachi *molli*, *submedullosa*, sulcato-striata, internodiis apice subhirsutis, ramis ramulisque *angulatis*, uno latere sæpe hirsutis, verticillis sæpe compositis, distantibus, spiculis 6–12 lin. longis, membranaceis, *pallidis*, foliis angustis, subconcoloribus, subtus hirsutis, vaginis superne hirsutis, oreque ciliatis.

Hab. in China, Formosa, no. 650! *Oldham.* v. s.

Culmus suffruticosus? vel herbaceus? (ramuli foliiferi 3–4, disjuncti, *internodiis inferioribus hirsutis* tantum adsunt). *Folia* 3–7 poll. longa, 6–8 lin. lata, apice setaceo-acuminata, basi rotundata vel cuneata, vix petiolata, supra uno latere marginibusque aspera, subtus vix pallidiora, hirsuta, nervis secundariis utroque latere 5–6. *Vaginæ* superne hirsutæ vel tandem glabrescentes, margine uno fimbriatæ, collo auriculatæ. *Panicula* aphylla (pars superior 5-pedalis adest), internodiis inferioribus 5–6 poll. longis, apice hirsutis, rhachi sulcato-striata, *molli*, fere medullacea, viridi-glauca, ramis inferioribus sæpe compositis, superioribus simplicibus, ramulisque angulatis, striatis, mollibus, *uno latere sulcatis* et sæpe *hirsutis*, glomerulis plerumque distantibus, sæpe compositis. *Spicula* pallida, 6-10–12 lin. longa, basi attenuata, 5–6-flora, flosculis 1–3 fertilibus, palea inferiore brevimucronata, superiore sub lente hirsutiuscula, carinis fimbriata. *Antheræ* obtusæ. *Stylus* cito 3-fidus. *Squamulæ* ovatæ, apice fimbriatæ, subæquales, tertia minor. *Ovarium* stipitatum, tandem subobovatum, apice vix hirsutum.

In spiculis perpaucis, forsan morbosis, palea superior *intus hirsuta*, *dorso rugosa*, squamulæ *carnosæ* et fusco-*hirsutæ*, cum ovario *rostrato* apice *glabro*, occurrunt.

This species, of which I have seen but one specimen, collected by the late Mr. Richard Oldham, in 1864, appears to be more herbaceous than any other *Bambusa*. The green, striated, almost *pithy* panicle, with angled branches, distinguishes it from all other allied species. *B. orientalis* of Nees approaches it in having a soft and striated panicle, but has a very different style and fruit.

7. B. TERES, hb. Ham. 881, Wall. Cat. 5026B. Culmo ignoto, paniculæ rhachi *eximie fistulosa, cava, striata, non* dura, ramis *angulatis*, spiculis in semiverticillis *paucis*, fertilibus $1\frac{1}{2}$–2 poll. longis, palea inferiore *longe acuminata*, antheris apice *penicillatis*; foliis $1\frac{1}{2}$–$1\frac{3}{4}$ poll. *latis*, 12–14 poll. longis, basi *attenuatis*, venulis *transversis crebris*, sæpe *conspicuis*, ligula *brevi*.

Hab. in Ind. or. Bengal, Gongachora, 881! *Hamilton, Griffith*! (folia tantum); Assam! *Jenkins* (flores sine foliis). v. s.

Culmus ——. *Folia* lanceolata, 12–14 poll. longa, $1\frac{1}{2}$–$1\frac{3}{4}$ poll. lata, basi inæqualia, attenuata, vix petiolata, apice rostrato-acuminata, margine brevissime serrata, supra glabra, sed uno latere tactu scabra: subtus pilis brevibus hirsuta, tandem glabrescentia, nervo centrali valido, secundariis utrinque 11–16 subconspicuis, venulis transversis sat crebris (inferne præcipue) conspicuis. *Vaginæ* pilis paucis, superne hirsutæ vel glabræ, infra petiolum membrana coriacea terminatæ, ore *nudæ, ligula brevi*. *Panicula* composita vel decomposita (nodi 3–4 tantum adsunt), rhachi 3–$3\frac{1}{2}$ lin. diametro, *eximie cava*, parietibus tenuissimis, striata, non dura, ramis *angulatis*, 1–2 longis, reliquis brevibus, vix compositis, erectis, ad nodos semiverticillatis, bracteis longis membranaceis stipatis. *Spiculæ* in glomerulis, basi bracteatis, paucæ, plerumque 1 fertilis et 1–2 steriles. Fertilis fere 2 poll. longa, non nitida, 7–8-flora, flosculis 6 sæpe fertilibus, rhachillæ articulis obcuneatis, apice fimbriatis. *Palea* inferior in flosculis infimis interdum apice subfoliacea, nervosa, plerumque longe acuminata, 10 lin. longa, margine fere glabra; superior inter carinas superne, nisi ipso apice, ciliatas 5–6-nervis, apice pilis penicillata. *Antheræ* apice penicillatæ. *Squamulæ* longe fimbriatæ, 10–14-nerves, subobovatæ. *Ovarium* apice hirsutissimum, subobovatum et rostratum, in stylum profunde 3-fidum.

I have only seen some portions of a panicle of this plant, and therefore have had but slight materials to describe a species from. However, the very hollow panicle, with large spiculæ, and much acuminated lower palea, combined with the broad leaves and their conspicuous transverse veinlets, serve to distinguish this from *B. tulda* and all its allies. The following species, *B. Falconeri*, has also broad leaves; but they are rounded at the base, and the ligules are much elongated, in addition to other (less conspicuous) points of difference. *B. Oldhami* has a panicle very similar to that of this species.

8. B. FALCONERI, Munro. Culmo vix elato?, fistuloso; panicula decomposita, rhachi approximatis, vix dense aggregatis, fertilibus 10–12 lin. longis, palea inferiore acuminata, antheris apice penicillatis; foliis 12–17 poll. longis, usque $3\frac{3}{4}$ poll. latis, basi rotundatis, venulis *transversis crebris*, sat *conspicuis*, ligula valde *elongata*.—*B. fistulosa*? Royle, MS. ad herb. 373!

Hab. in Ind. or. Himalaya, Gurhwal, Dehra Dhoon! alt. 2000–3000 ped. s. m., *Falconer* (florifer); Okeemath? ("Chye" incolis), 4000 ped. s. m., *Strachey et Winterbottom*! (folia tantum, dubia); Himalaya ("Kag"), *Royle*. v. s.

Culmus fistulosus, an subarboreus?, internodiis apice farinoso-hirsutis. *Folia* (quodam *modo* dubia) ovato-lanceolata, basi æqualia, subrotundata, apice attenuato-acuminatissima, margine scabra, 12–18 poll. longa, medio 3–$3\frac{3}{4}$ poll. lata, supra glabra, subtus punctis minutissimis scabriuscula, inferne interdum pilis brevibus subhirsuta, nervis secundariis utrinque 12–16, venulis *transversis* sat *conspicuis*. *Vaginæ* primum hirsutæ, tandem pilorum residuis scabræ, ore cfimbriatæ, ligula conspicua,

elongata. *Panicula* decomposita (pars superior 3-pedalis adest), internodiis 5–8 poll. longis, rhachi pallide virente, striata, non dura, ramulis ad nodos subdense verticillatis, 1–2 sesquipedalibus, reliquis brevibus, internodiis subangulatis, plerisque apice subviscido-hirsutis, spiculis pallidis, plurimis sterilibus, gemmiparis, in verticillis sæpe compositis vix dense aggregatis. *Spicula* fertilis 10–12 lin. longa, sub 10-flora, flosculis 4–5 supremis gradatim tabescentibus, rhachillæ articulis cuneatis, apice pilis longis ciliatis. *Palea* inferior nervosa, margine vix fimbriata, acuminata; superior angustior et brevior, inter carinas longe ciliatas 5–7-nervis. *Squamulæ* 3, tenues, subæquales, duæ interdum obliquæ, obtusæ, vix nervosæ, longe fimbriatæ. *Antheræ* pilis 1–2 vel plurimis penicillatæ. *Ovarium* subobovatum, apice pilis longis hirsutum, in stylum cito trifidum vix rostratum.

As regards inflorescence, this species is to be distinguished from *B. teres* by having a much less hollow panicle, very much smaller, more densely crowded, and paler-coloured spiculæ, with the lower palea much less acuminated. The panicle, in general appearance, bears a considerable resemblance to that of *B. nutans*. I do not feel quite certain about the foliage. The flowering specimens were collected by Falconer in the Dehra Dhoon in September 1840, and the leaves in October 1839; and it is, therefore, just possible that they may have belonged to different species. The specimens collected in the interior of Gurhwal by Strachey are a little doubtful. They are evidently taken from young, almost undeveloped shoots; and the ligules are rather shorter than in Falconer's specimens, and the leaves have fewer secondary nerves; but in other respects they agree very well.

9. B. BREVIFLORA, Munro. Culmo inermi, arborescente?, *subsolido*, ramis *inferioribus* sæpe *basi foliatis*, *apice floriferis*, superioribus foliiferis tantum; panicula in ramo terminali, *subspicata*, verticillis paucispiculatis, spiculis *brevibus*, vix 6 lin. longis, *viridis*, paucifloris, flosculis 2–3 perfectis, his palea *superiore inferiorem obtusam*, brevissime mucronatam *superante*, ovario subobovato; foliis parvis, subtus hirsutis, vaginis ore utrinque ciliato-auriculatis.

Hab. in China, Formosa, Tamsuy, 651! *Oldham*; Lintao! *Dr. Cantor in herb. Benth.* (quoad flores, folia aliena sunt—*B. Cantori*). v. s.

Culmus arborescens?, subsolidus, durus, nitidus, internodiis 5–6 poll. longis (in spec. viso 3-pedali), ramis ad nodos fasciculatis, inferioribus inferne nodosis, teretibus, simplicibus vel compositis, apice floriferis, sæpe basi foliatis, foliis cito caducis, superioribus foliiferis tantum, adjecto hinc et inde ramulo florifero, basi nudo. *Folia* lanceolata, $1\frac{1}{2}$–4 poll. longa, 6–8 lin. lata, basi rotundata, petiolo brevi, compresso, apice setaceo-acuminata, margine aspera, vix serrata, subglabra, subtus hirsuta; nervis secundariis utrinque 4–5, vix a tertiariis discernendis. *Vaginæ* sulcatæ, glabræ, utrinque auriculatæ, auriculis ciliis, interdum 8 lin. longis fimbriatæ. *Panicula* in ramis vel ramulis terminalis, verticillato-spicata, verticillis subæquidistantibus, paucispiculatis, simplicibus. *Spicula* subcylindrica, acuta, sub 6 lin. longa, rhachillæ articulis brevissimis, livida, nitida, 5–7-flora, flosculis 3–4 terminalibus gradatim tabescentibus, intermediis 2–3 perfectis, his palea inferiore nervosa, glabra, obtusa, sed brevissime mucronata, a palea superiore (submembranacea, inter carinas superne tenuiter fimbriatas 5–7-nervi) superata. *Squamulæ* longe fimbriatæ, inconspicue nervosæ. *Antherarum* connectivo obtuso-elongato. *Stylus* cito 3-fidus in stigmata sublonga. *Ovarium* stipitatum, obovatum, apice hirsutum.

The nearly simply spicate and fascicled panicles and very small darkish-coloured spiculæ distinguish this from all the species of *Bambusa* which have an obovate ovary.

The leaves attached to Dr. Cantor's specimen are deeply tessellated on both sides, and appear to belong to a very different plant. The flowers are, I feel persuaded, identical with the plant above described.

10. B. PALLIDA, Munro. Culmo inermi, fistuloso, florifero basi efoliato, foliis reliquis minoribus, raro inflorescentiam intrantibus; panicula glaberrima, ramis semiverticillatis, patulis; spiculis *pallidis*, *biformibus*, cylindricis, in glomerulis, per ramos ramulosque dissitis, aggregatis, spiculis perfectis *subuncialibus*, flosculis 3–4 hermaphroditis, supremis hirsutiusculis, rhachilla vix unquam visibili, palea inferiore superiore subduplo longiore, stylo cito 3-fido, ovario *lineari-oblongo*, *apice attenuato*, foliis angustis, basi attenuatis, subtus pilis longis hirsutis.

Hab. in Ind. or. Bengalia orient. Pundua! et Silhet! cult. (floriger!), Cachar ("Burwal" et "Bakhal" incolis) (folia tantum), Khasia, Joowye, alt. 3500 ped. s. m., no. 602! et 607! *Kew Mus.* ("Usken" incolis) (folia tantum), *Hooker et Thomson.* v. s.

Culmus 50-pedalis, erectus, fistulosus, cavus, glaber, inermis, diametro 2–2½ poll., internodiis superioribus 4–7 poll. longis, spathis 3–4 poll. longis, pilis fuscis, basi bulbosis hirsutis, apiculo 4–7-unciali, e basi amplissima, culmis junioribus foliacea, eximie auriculata, attenuato. *Folia* lineari-lanceolata, 4–8 poll. longa, 5–7 (raro 14) lin. lata, membranacea, basi subcuneata, vix petiolata, supra glabra, sed uno margine tactu scabra, subtus sæpe pallidiora, pilis sublongis hirsuta, nervis secundariis utroque latere sub 4–6 raro 8, margine serrata. *Vaginæ* glabræ, sulcato-striatæ, lateribus productæ et interdum conspicue auriculatæ, auriculis ciliis perpaucis, subrigidis, cito caducis fimbriatis, ligula brevissima. *Panicula* ramosa, rhachi fistulosa, glaberrima, ramis inæqualibus, simplicibus vel compositis, spiculis plurimis sterilibus, cum paucis (1–4) fertilibus ad nodos ramorum ramulorumque semiverticillatis, verticillis rarissime proliferis. *Spicula* pallida, sterilis 3–5 lin., fertilis 12–14 lin. longa, 7–10-flora; flosculo infimo (fertilis) masculo, sequentibus 3–4 perfectis, terminalibus 3–5 gradatim tabescentibus et sæpe dorso, basin versus, hirsutis; rhachillæ articulis inferioribus brevissimis, apice incrassatis et fimbriatis. *Palea* inferior dorso glabra, intus pubescens, multi(20)-nervis, mucronata, superiorem attenuatam, carinis breviciliatam longe superans. *Antherarum* connectivum *seta* subnata, superiorem attenuatam, carinis breviciliatam longe superans. *Squamulæ* oblongæ, membranaceæ, basi 2–3-nerves, apice longe fimbriatæ. *Stylus* cito 3-fidus in stigmata 3 brevia, pulchre plumosa. *Ovarium* (immaturum) apice attenuatum, nullo modo obovatum. *Caryopsis* ignota.

This bears a considerable resemblance to *B. tulda*, from which, however, the attenuated ovary at once distinguishes it. Very few of the spiculæ (sometimes only 2–3 on a branch) appear to be perfect; the sterile spiculæ are numerous and very much smaller.

11. B. KHASIANA, Munro. Culmo fistuloso, vix duro, inermi; ramulis paniculæ floriferis inferioribus verticillatis, superioribus alternis, basi vel nudis vel foliiferis, spiculis tandem complanatis, sub 9 lin. longis, in glomerulis sæpe distantibus, densifloris vel paucifloris, aggregatis, palea inferiore superiore vel breviore vel æquilonga, stylo 3-fido, ovario *rostrato*, *rostro glabro*; foliis lanceolatis, *acumine hirsutissimo* terminatis, vaginis primum ore fimbriatis.

Hab. in India or. Khasia 2000 to 4000 p. s. m., Churra, no. 1097!; Jasper Hill, Mahadeb, no. 496! ("Tumar" vel "Tomar" incolis), *Hooker.* v. s.

Culmus fistulosus, glaber, suffruticosus?, spathis subsemipedalibus, basi barba fulva cinctis, dorso pilis nigris, bulbosis hirsutis, margine longe ciliatis, apiculo triangulari, basi fimbriato, brevissimo, 3–5 lin. longo terminatis. *Rami* foliiferi geniculati, pauci (5–8), basi bracteati, verticillati, apice folia pauca (3–5) gerentes. *Folia* plerumque 4–6 poll. longa, et 9–12 lin. lata, in ramulis floriferis 8 poll. longa, et 18 lin. lata, lanceolata, basi rotundato-attenuata in petiolum sublongum, *acumine*, præcipue in foliis junioribus, *hirsutissimo* terminata, utrinque glabra, nervis secundariis plurimis, ægre a tertiariis discernendis, membranacea, pallida. *Vaginæ* glabræ, breviter subbiauriculatæ, ore ciliis paucis, *fuscis, plicatis*, cito deciduis fimbriatæ, ligula demum elongata. *Paniculæ* ramis inferioribus verticillatis, simplicibus, valde inæqualibus, superioribus alternis, sæpe gracilibus, loriformibus, basi plerumque nudis, interdum paucifoliatis, spiculis glomerato-verticillatis, verticillis 6–1 poll. et minus distantibus. *Spicula* fertilis 7–9 lin. longa, primum cylindrica, demum complanata, glabra, 5–6-flora, rhachillæ articulis striatis, apice fimbriatis, flosculo inferiore bipaleaceo, masculo vel neutro, 2–3 sequentibus subpatulis, fertilibus, 1–2 superioribus tabescentibus, gluma inferiore gemmipara, superiore 5–7-nervi, margine subfimbriata. *Palea* inferior (fertilis) acuminata, multinervosa, glabra; superior vel longior vel subæquilonga, carinis breviciliata. *Squamulæ* variabiles, ratione spiculæ magnæ, ovales, toto margine fimbriatæ, obtusæ, in flosculis 2 inferioribus paucinerves, nervis coloratis valde conspicuis, in tertio fertili multinervosæ, nervis minus conspicuis. *Antherarum* connectivum obtusum. *Stylus* cito 3-fidus, stigmatibus sublongis, tenuibus. *Ovarium* (immaturum) lineari-oblongum, rostratum, rostro glabro, styli 3-fidi residuis coronatum.

This is a well-marked species, readily distinguished from all others of the genus by the peculiar long beard at the base of the spathes, combined with the long hairy point to the leaves. The specimens I have seen do not enable me to state whether the leaf-bearing and flowering culms are generally distinct. The plant appears to be confined principally to the lower and warmer slopes of the Khasia mountains.

12. B. POLYMORPHA, Munro. Culmo excelso, inermi, fistuloso, duro, internodiis apice pilis adpressis albidis, hirsutis, florifero basi aphyllo; panicula supra decomposita, ramis ramulisque polymorphis, nunc brevibus vel brevissimis, verticillis spicularum, paucifloris, approximatis, nunc 2–3-pedalibus, verticillis densifloris, 4–6 poll. distantibus, spiculis interdum monoicis vel dioicis, 3–6 lin. longis, palea inferiore obtusa, mucronata, superiore *carinis glabra*, antheris sæpissime seta apiculatis, ovario subrostrato, rostro *hirsuto*; foliis angustis, utrinque *hirsutiusculis*, vaginis eximie auriculatis.

Hab. in Ind. or. Martaban, Pegu! ("Kijathounwa" incolis), no. 1, *Brandis*; Rangoon, *M'Clelland*. v. s.

"*Culmus* arboreus, 60–80-pedalis, rectus, apice leniter curvatus, inferne nudus, superne ramis semiverticillatis comosus, diametro maxima 6-pollicari, parietibus tenuibus, annulis horizontalibus, internodiis 1–2 ped. longis" (Brandis); spathis crassis, coriaceis, intus nitidis, pilis paucis sparsis, extus pilis canescentibus adpressis, medio affixis, glaucescentibus, "fauce lacero-dentatis, ciliatis, apiculo cucullato, mucronato, laxe adpresso." *Folia* tenuia, lineari-lanceolata, basi inæqualia, subattenuata, apice setaceo-acuminata, margine aspera, vix serrata, 5–6½ poll. longa, 4–7 lin. lata, supra, punctulis minutissimis tota superficie scabriuscula, pilis paucis sparsis, utroque margine et medio aspera, subtus pilis crebris hirsuta, nervis secundariis utroque latere 6–8, subconspicuis. (*Folia* pauca, raro inflorescentiam intrantia, minora, vix 3 lin. lata, 2½–4 poll. longa.) *Vaginæ* carinatæ, compressæ, striatæ, inter strias hirsutæ, margine uno fimbriatæ, apice abrupte terminatæ, lateribus auriculatæ, auriculis sæpe elongatis, ciliis longis fimbriatis, ligula vix ulla. *Panicula* supra decomposita, inter-

nodiis (visis) 4–6 poll. longis, apice *pilis adpressis hirsutiusculis*, ramis sæpe numerosis semiverticillatis, nunc brevibus et tenuibus, 2–7 poll. longis, verticillis subapproximatis, paucifloris, nunc adjectis ramis 2–3, valde elongatis, verticillis densifloris, simplicibus vel compositis, 4–6 poll. distantibus. *Spicula* cylindrica, nitida, 3–6 lin. longa, interdum monoica et forsan dioica, mascula sæpe violaceo colorata, fertilis pallida, 6 lin. longa, sub 6-flora, flosculis 1-2 inferioribus neutris, 1-paleaceis, 2–3 fertilibus, terminali tabescente sublongipedicellato, rhachillæ articulis reliquis brevibus. Spiculæ interdum viviparæ, elongatæ, paleis inferioribus apice foliaceis. *Palea* inferior (flosculi fertilis) nervosa, *obtusa*, brevissime mucronata, glabra; superior æqualis vel longior, obtusissima, carinis *glaberrima*. *Squamulæ* obovatæ vel ovatæ, toto margine fimbriatæ, basi venosæ, tertia minor. *Antheræ* interdum seta apiculatæ, interdum, præcipue in spiculis masculis, nudæ. *Stylus* in stigmata longa, pilosa, fere ad rostrum 3-fidus. *Ovarium* apice hirsutum, subito rostratum, rostro hirsuto, raro fere obsoleto.

The individual spicula of this species is certainly very like that of *B. brevifiora*, but is at once distinguished by the comparatively long-stalked terminal flower. In size, foliage, and general inflorescence, the two plants are widely different. Dr. Brandis says that this species is common throughout Pegu on hills, and is associated with Teak.

13. B. Griffithiana, Munro. Culmo gracili, subscandente, fistuloso, cavo, florifero (an semper?), foliifero; panicula vel ramosa ramis alternis, vel fere spicata, spiculis 6–7 lin. longis, in glomerulis parvis distantibus aggregatis, flosculo non nisi *penultimo hermaphrodito*, *terminali* tabescente, *longe stipitato*; foliis *magnis*, subtus *discoloribus*, venulis *transversis crebris*, vaginis collo auriculato fimbriatis.—*Bambusa*, sp., Griff. Journ. p. 90.

Hab. in Ind. or. Burmah, Mogoung! *Griffith.* v. s.

Culmus gracilis, fistulosus, cavus, non durus, subscandens, foliifer sæpe apice florifer. *Folia* magna, 1–1½ ped. longa, 2–2¾ poll. lata, valde discoloria, supra (an siccando tantum?) fusca, subtus pallidiora, apice acuta, basi vix rotundata, inæquilatera, in petiolum brevem, crassum, rugosum attenuata, utrinque marginibusque subglabra, nervo centrali valido, secundariis tota lamina 30, subconspicuis, *venulis transversis crebris*, subtus plus minus elevatis. *Vaginæ* dorso obtuse carinatæ, glabræ, utrinque auriculam magnam, reversam, margine ciliis validis numerosis fimbriatam gerentes, ligula elongata, obtusa, ciliata. *Panicula* terminalis, vel ramosa, ramis paucis alternis, vel simplex, usque 6–7 ped. longa., verticillato-spicata, glomerulis parvis distantibus. *Spicula* cylindrica, sessilis, 6–7 lin. longa, 5-flora, flosculis 3 inferioribus *unipaleaceis*, *neutris*, gradatim increscentibus, *penultimo hermaphrodito*, terminali tabescente longe pedicellato, rhachilla brevissima, nunquam visibili. *Palea* inferior (fertilis) membranacea, glabra, brevissime mucronata, multinervis, basi involuta: superior subæquilonga, tenuimembranacea, hyalina, inter *carinas obtusas*, *glabras* sulcata, pedicellum flosculi imperfecti arcte involvens. *Squamulæ* 3, longe fimbriatæ, nervosæ, hyalinæ, 2 obtusæ longiores, tertia sublanceolata. *Antheræ* obtusæ. *Stylus* fere ad basin in stigmata pulchre plumosa 3-fidus. *Ovarium* (immaturum) rostratum, *rostro glabro*.

In habit of growth, foliage, long spike-like hollow panicle, and structure of the spicula, with only one perfect flower, this is widely separated from all other species of *Bambusa*. In the composition of the spicula it is very closely allied to the genus *Nastus*. *B. Khasiana* approaches it in some respects, but has always more flowers in the spicula, and the leaves are very different. It appears to have been found once only by Griffith

in his journey from Hookoom Valley to Ava, associated with numerous tropical plants on the banks of the river Mogoung, in the extreme north of Burmah.

14. B. BALCOOA, Roxb. Hort. Beng. 25 (1814); Fl. Ind. ii. 196, icon. 1402 ! Culmo excelso, fistuloso, panicula "*scapiformi*, radicali, spicis verticillatis" (Roxb.), ramis interdum elongatis, internodiis ramorum *uno latere sulcatis* et *hirsutis*, spiculis glomeratis, *ovatis*, *mollibus*, 6–8-floris, flosculis 4–6 hermaphroditis, palea inferiore *margine fimbriata*, superiore et *carinis* et *margine ciliata*, stylo hirsuto, *ad* vel paulo *infra medium* 3-fido ; foliis sæpe pedalibus, vaginis *hirsutis*.—Cat. of B. G. Calc. 79. *B. capensis*, Rupr. *l. c.* 144, t. xii. f. 54 ; Steud. *l. c.* 330. *B. vulgaris*? Nees Fl. Afr. Aust. 462, non alior. *B. vasaria*, herb. Hamilton, no. 883, in Wall. Cat. 5025 ! an etiam *Arundarbor vasaria*, Rumph. Amb. iv. 8. *Arundo bambos*, herb. Smith ! e Thouin, no. 230 ! non Linn.

Hab. in Ind. or. Bengalia ("Balkoo Bans" incolis), *Roxburgh* ; Birgunge, no. 883 ! *Hamilton* ; Purnea Kishengunge ! Megna,' 202 !, Cachar ! ("Betwah"), *Hooker et Thomson* ; Boglepore, 44 ! *Pinwell* ; Assam, Seebsagur ("Burra Balooka"), 947 ! *Masters* ! ; cult. C. B. S. *Ecklon, Mund* !, no. 1045–3, *Burchell* ! ; Paris, *Thouin* ; in hb. Smith ! Crystal Palace ! v. s.

Culmus arboreus, excelsus, 50–70-pedalis, cavus, inermis. *Folia* lanceolata, basi subcordata vel attenuata, petiolata, petiolo supra subhirsuto et sæpe transverse ruguloso, margine hispida et interdum basin versus longe ciliata, utrinque viridia vel raro glaucescentia, 6–12 poll. longa, 1–2 poll. lata, supra tactu scabra, subtus pilis brevibus, demum deciduis hirsuta, nervis secundariis utroque latere 7–11, venulis transversis distantibus, plus minus conspicuis. Folia inflorescentiam intrantia multo minora sunt. *Vaginæ* striatæ, setis diaphanis, dein deciduis hirsutæ, apice truncatæ, ore plerumque nudæ vel pilis paucis ciliatæ, ligula producta, obtusa, ciliata vel glabra. *Inflorescentia* "scapus radicalis, spicis verticillatis, verticillis interdum proliferis" (teste Roxburgh) ; interdum panicula composita, internodiis subteretibus, apice hirsutiusculis, ramis ad nodos paucis, 2–3, simplicibus vel raro compositis, 6–18 poll. longis, internodiis uno latere sulcatis et hirsutis, spiculis plerumque subdense glomeratis in verticillos, vel approximatos, vel 1–2½ poll. a seipsis invicem remotos ; interdum (*e. g.* in spec. e C. B. S. in herb. Hook.) panicula inferne ramosa, ramis inferioribus et spicigeris et foliiferis ad eundem nodum, superne subverticillato-spicata, verticillis densis, globosis, ramulos 1–2 breves interdum emittentibus. (Hæc forma *B. capensis*, Rupr. est.) *Spicula* 4–6 lin. longa, ovata, mollis, violacea (in icon. Roxb.), 6–8-flora, flosculo infimo et supremo sterilibus, reliquis 4–6 hermaphroditis, rhachilla abscondita. *Palea* inferior nervosa, membranacea, ovata, mucronata, margine superne fimbriata, (lævis, *Roxburgh*), pallide straminea vel demum fuscescens, inflata ; superior vix brevior sed angustior, inter carinas nervis 4 *anastomosantibus* percursa, *carinis et margine* hispido-ciliata. *Squamulæ* 3, variabiles, plerumque ovales, membranaceæ, longe ciliatæ, inæquales, duæ obtusissimæ, tertia longior, sublanceolata. *Antheræ* seta cito caduca apiculatæ. *Stylus* hirsutus, ad vel paulo infra medium in stigmata 3 sublonga, flexuosa, hirsuta divisus. *Ovarium* (immaturum) rostro hirsuto, in stylum attenuatum.

In numerous respects, especially in the form of the spicula, this species very closely approaches *B. Beecheyana* and *B. Oldhami* ; but the much thicker and more deeply trifid styles have induced me to place it in the first section of the genus. Roxburgh, whose drawing represents apparently a young undeveloped flowering culm, states that he never saw this species but once in flower : and flowering specimens must still be very rare ; for I have never seen anything like a perfect one ; and most of those which I have quoted

are in leaf only. Dr. Hooker's specimen from Kishengunge is the only one that gives any information as to the structure of the panicle. Dr. Hamilton's, which is the only other Indian one I have seen in flower, contains merely a single detached branch of a panicle. Mund's, from the Cape, is evidently in an abnormal leaf-bearing condition; and the only remaining flowering specimen, namely that from Burchell, contains two or three detached branches of a panicle. Roxburgh states that the bamboo-workers of Bengal consider this to be the very best Bamboo for building houses, scaffolding, &c., but that in order to render it durable, it requires long immersion in water.

15. B. FLEXUOSA, Munro. Culmo florifero basi aphyllo, spinoso, 6–12-pedali; panicula decomposita, ramulis tenuibus, ad nodos spiculas paucas, latas, compressas, multifloras gerentibus, rhachilla spiculæ conspicua, valde *flexuosa*, glumis linearibus, acutis, paleis *hiantibus*, ovario rostrato; foliis lanceolatis, brevibus.—"*Humilis spinosa*," Osbeck in "Resa," 204 (1757).

Hab. in China, circa Cantonem, no. 10,000, *Hance*!; Quantung, *Sir G. Staunton*! *in herb. Mus. Brit.* (folia tantum). v. s.

Culmus suffruticosus, "6–12-pedalis," spinosus, viridis, diametro 1½ lin., internodiis glabris, striatis, 2–3 poll. longis, ramis 1–3, cum spinis 1–2 (in inferioribus) ad nodos locatis. *Folia* parva, lanceolata· maxima (in speciminibus visis) 2 poll. longa, 5–6 lin. lata, basi rotundata, petiolata, apice mucronato-acuta, margine, præcipue in foliis junioribus, longe ciliata, utrinque glabra, nervis secundariis inconspicuis, utroque latere 3–4. *Vaginæ* glabræ vel hirsutæ, striatæ, margine læves, infra petiolum membrana sæpe tenuiter ciliata terminatæ, ore ciliis tenuissimis cito caducis fimbriatæ, ligula subelongata, sæpe longe ciliata. Culmi floriferi dispositio ramorum ut in foliifero, ramulis simplicibus vel compositis, foliis hinc et inde sparsis, cito deciduis, spiculis in ramulis approximatis, inferioribus geminis vel ternis, superioribus alternis, 10–14 lin. longis, eximie compressis, sessilibus vel interdum pedicellatis. *Spicula* 8–12-flora, flosculo inferiore interdum et superioribus 2–3 masculis vel neutris, reliquis intermediis perfectis, hermaphroditis, distichis, divaricatis, *paleis hiantibus*, articulis rhachillæ apertæ, conspicuæ, flexuosæ longis, hirsutis, compressis; glumis linearibus, acutis, sæpe distantibus. *Palea* inferior rostrato-acuminata, glaberrima, nervis inconspicuis 7–9–11, in flosculis inferioribus longe, in superioribus paulo, superiorem subcymbiformem, dorso canaliculatam, carinis plus minus ciliatam superans. *Squamulæ* 3 subæquales, apice rotundato-obtusissimæ, longe fimbriatæ, nervosæ, nervis, sæpe curvatis, squamulæ marginem percurrentibus. *Stamina* 6, filamenta basi expansa, antheris obtusis. *Stylus* basi subbulbosus, primum indivisus, sed cito in stigmata 3 pulcherrime penicillata, *inferne nuda*, fere ad bulbum 3-partitus. *Caryopsis* lineari-oblonga, vix 2 lin. longa, apice glabra et basibus styli trifidi tricornuta.

This has a different look from all other Bambusæ. The perfect spicula has the rhachis as much exposed as it often is in *Brachypodium*, to which it bears some resemblance. The gaping paleæ also give the plant a very peculiar appearance. Osbeck, in speaking of this plant, collected during his travels in China in 1751, says that it is generally 6 feet, but occasionally 12 feet, high, and that it is said to flower once in sixty years.

16. B. BLUMEANA, Schultes, Syst. vii. 2. 1343 (1830). Culmo elongato, spinoso, paniculo "laterali" (Schult.), decomposita, patula, ramis plerumque solitariis, inferioribus 15 poll. longis; spiculis vix compressis, verticillato-glomeratis, rhachillæ

tandem conspicuæ articulis *hirsutis*, flosculis imbricatis, palea inferiore mucronato-acuta, stylo profunde 3-fido, caryopsi subtricornuta; foliis 3–6 poll. longis, utrinque glabris.—Kunth, Enum. 431. *B. spinosa*, Blume in litt. ad Nees ab Esenbeck, in Bot. Zeit. 1825, p. 580, non Roxb. *B. agrestis*? Poir. Enc. viii. 704 (1808); Sch. *l. c.* 1344; Rupr. *l. c.* 149; Kunth, *l. c.* 432; Steud. *l. c.* 330. *Arundo agrestis*? Lour. Fl. Coch. i. 72; forsan *Arundarbor spinosa*, s. *Bulu Baduri*, *Teba Teba*, Rumph. Amb. iv. 14, t. 3. *B. teba*, Miq. Fl. Ind. Bat. iii. 418. *Schizostachyum durie*, Rupr. *l. c.* 136; Steud. *l. c.* 332, sed vix Miq. *l. c.* 425. *Ischurochloa spinosa*? Büse in Pl. Jungh. 390, Miq. *l. c.* 422 (syn. plur. exc.), Walp. Ann. vii. 1045.

Hab. in Java, *Rumph.*, *Junghuhn*, ("Tring ori," "Tring ampel" et "Giping" incolis) no. 313! *Horsfield*, ("Hauer Tjutjuk" vel "Bambu Durie") *Blume*; ins. Soembawa, no. 3417, *Zollinger* (teste Miquel); Amboina? Coram? Manipa? *Rumph.*; Cochin China? *Loureiro*. Vidi spec. plur. in herb. Horsfield.

Culmus erectus, elongatus, spinosus, "spinis ternis recurvis, crassitie 1–2 poll., haud scandens," internodiis superioribus cinerascenti-flavicantibus, *glabris*, *teretibus*, inconspicue striatis, $1\frac{1}{2}$–2–4 poll. longis. *Rami* ramulosi, ad nodos pauci, basi incrassati, geniculati, ramulis numerosis, gracilibus, aliquid deflexis, internodiis ramulorum sæpe apice *scabris*. *Folia* tenuia, lineari-lanceolata, cuspidata, basi interdum rotundata, plerumque abrupte attenuata in petiolum glabrum, 3–6 poll. longa, vel raro minora 9–30 lin. longa, 3–7–9 lin. lata, margine serrata vel etiam fimbriata, utrinque glabra, subtus glaucescentia, $\frac{1}{3}$ laminæ nitida, nervis secundariis utroque latere 5–7. *Vaginæ* striatæ, margine uno ciliatæ, in siccis pallide fuscescentes, primum pilis sparsis, adpressis hirsutæ, demum glabriusculæ, ore utrinque ciliis paucis (sæpe cito deciduis) fimbriatæ, ad apicem infra petiolum fovea parva sub lente ciliolata, ligula truncata, brevi, pilis sublongis, demum deciduis ciliata. *Panicula* (lateralis, testibus Blume et Schultes), ut videtur, ampla, gracillima, ramosa, apice nutans et simpliciter verticillato-spicata (pars superior 3-pedalis adest), internodiis inferioribus 3–$4\frac{1}{2}$ poll. longis, ramis plerumque solitariis, alternis, raro (in spec. uno) ternis, inferioribus 15 poll., sequentibus 10–8–7 poll. longis, gracilibus, suberectis, divaricatis, supremis interdum 2–$2\frac{1}{2}$ poll. longis, erectis, densifloris, fere spicatis, verticillis approximatissimis, imbricatis. *Spiculæ* per ramos, ad intervalla regulariter et gradatim e basi decrescentia, glomerato-verticillatæ, patulæ, plurimæ breves, steriles, subulatæ, paucæ fertiles, subpollicares. Spicula fertilis subcompressa, pallida, rhachillæ tandem conspicuæ articulis $1\frac{1}{2}$ lin. longis, hirsutis, 8–10-flora, flosculis 3–5 intermediis perfectis, 1–2 infimis et 2–3 supremis bipaleaceis sed sterilibus. *Palea* inferior (fertilis) 4 lin. longa, inferne lævis, superne costato-nervosa, apice subulato-acuminata; superior vix brevior, carinis et sæpe margine basin versus ciliata. *Squamulæ* 3, obovatæ, longissime ciliatæ, subæquales, interdum basi callosæ et nervosæ. *Antheræ* obtusæ. *Stylus* brevis, cito in stigmata 3, pulcherrime plumosa, fere ad basin divisus. *Ovarium* subtriquetrum, apice, vix hirsuto, residuis stylorum tricornutum.

Having seen several excellent specimens of this plant in Horsfield's Herbarium, I have been able to add some particulars to the description of the species given by Schultes, who states that all the spiculæ he saw were sterile. I can see nothing to justify the panicle being called lateral; on the contrary, it appears to me to be decidedly terminal and unusually elegant and slender. Blume states that this plant is spinous; and there are some traces of spines in the specimens which I have seen; but there is nothing to indicate that it is as spinous as *B. agrestis* of Poir. and *Arundarbor spinosa* of Rumph. are described to be. *B. agrestis* is also described by Loureiro as having a bifid, not trifid style. I have therefore included these two species as probable synonyms only. Had I been fully persuaded of their identity, the earlier name of *B. agrestis*, Poir., ought to have been adopted for the

species. One of Horsfield's specimens is marked "Tring ampel;" it has certainly no thorns, but I am not able to distinguish it in any other respect from the remaining specimens. Miquel, at p. 418 of the "Flora Indiæ Batavæ," states that "Ampel" is the native name of his *B. fera* (*Arundarbor feræ species prima* of Rumph). The style, deeply trifid to near the base, the very hirsute joints of the rhachilla, and the somewhat 3-horned fruit separate this species from *B. spinosa*, Roxb., and its allies *B. arundinacea* and *B. orientalis*.

17. B. ARUNDINACEA, Retz. Obs. v. 24. (1789) sub *Bambos*. Culmo spinoso, florifero basi aphyllo, foliis sæpe inflorescentiam superne intrantibus, panicula ramosissima, ramis compositis et decompositis, interdum filiformibus, rhachi plerumque *glaberrima*, *nitida*, spiculis *rarissime* agglomerato-verticillatis, plerumque geminis vel ternis vel etiam supremis *solitariis*, interdum *pedicellatis*, 8–12 lin. longis, 6–12-floris, raro monoicis, rhachilla subhirsuta, plus minus *visibili*, palea inferiore *acuminata*, dorso glabra, margine nunc superne nunc inferne *tenuiter ciliata* vel omnino glabra, superiore, in flosculis perfectis, *inferiorem superante*, carinis plerumque longe ciliata, stylo basi subbulboso, cito in stigmata 2–3 profunde diviso, foliis plerumque 3–6 poll. longis, majoribus interdum pedalibus, basi cuneatis vel rotundatis, vaginis ore fimbriatis vel tandem nudis.—Willd. Sp. Pl. ii. 245 (1797); Roxb. Corom. Pl. i. 56, t. 79, Hort. Beng. 25 (1814), Fl. Ind. ii. 191; Poir. Enc. viii. 701; Spreng. *l. c.* ii. 112; Link. Hort. Berol. i. 249; Rœm. et Sch. *l. c.* 1340; Kunth, Enum. 431, non Nees in Linn. ix. 475; Dalzell et Gibson, Bomb. Fl. 299. *B. spinosa*, Nees, *l. c.* 474, et Rupr. *l. c.* 142, tab. xii., xiii. fig. 52; Steud. *l. c.* 329, sed non Roxb. *B. arundo*, hb. Klein. Nees, *l. c.* 471; Rupr. *l. c.* 143, t. xiii. fig. 53; Steud. *l. c.* 329; Benth. in Fl. Hongk. 434 (var. foliis floralibus basi rotundatis, vaginis ore, ciliis caducis, nudis). *B. orientalis*, Nees in Wight, 206 B!=1800! *B. Neesiana*, Arn. MS. *Arundo bambos*, Linn. Sp. Pl. ed. i. 81 (1753), teste herb. Linn.! *Bambos arundinacea*, Pers. Syn. i. 393. *Nastus arundinaceus*, Sm. in Rees's Encyc. no. 1; Rasp. *l. c.* v. 442; *Ily*, Rheede, Hort. Mal. i. 25, t. xvi. (Auctores pristini plures species *Bambusæ* sub *Arundine Bambos* confudisse videntur, quapropter synonyma, a Linnæo celebri citata, hic omissa).

Hab. in Indiæ or. peninsula, *Kœnig*! *in herb. Mus. Brit., hb. Heyne, in Wall. herb.* 5023 A; "Tanshaur, July 1798, Bambus arundo," *in Wall. herb.* 5023 B!=*Wight*, 205! 1801! ("*Bambos arundo*," Retz. 440, in Wight, 204! 1799!); Quilon, *Wight*, 1343! (var. fol. floralibus basi cordatis); Courtallum, *Wight*, 1344! 3346!; Nundidroog, *herb. Rottler*!; Madras, *Wight*! *Dr. Shuter*!; Poonamalee, *G. Thomson*, 110! 161! (var. spiculis elongatis et foliis majoribus); Bombay ("Maudgay" incolis), *Dalzell*; Kala Nuddie, *Ritchie*, 822! (folia tantum). In Bengalia, teste *Roxburgh*; China, Hong Kong, cult., *Hance*! (dubia). In hort. Kew! cult. v. s. et v.

Culmi 20–50?-pedales, "diametro 3-poll.," per 10–20 pedes stricti, tunc ad alterum latus flexi, anguste fistulosi, sæpe pallide straminei, teretes, duri, glabri, ramosissimi, spinosi, spinis sæpe aduncis "spathis 12–15 poll. longis, ore setigeris, apiculo acuminato, 3–5-pollicari, extus puberulis, intus argenteo nitidis" (*Dalzell*). *Folia*, in speciminibus a me visis, 3–8 poll. longa, 4–12 lin. lata, "12–15 poll. longa, ¾–2 poll. lata" (*Dalzell*), interdum 2–4 poll. lata (*Roxb.*), lanceolata, apice acuminata, basi attenuata vel subcordata, læviuscula vel supra marginibusque brevissime serrulatis tactu scabra,

subconcoloria, nervis secundariis subinconspicuis, 5–6 utroque latere. *Vaginæ* primum hirsutæ, demum glabrescentes, ore ciliis paucis, vix cito deciduis fimbriatæ. *Panicula* ingens, ramis numerosissimis, semiverticillatis, simplicibus compositisve, sæpe longis, decurvis aut pendulis, spinosis, spiculis rarissime dense glomeratis, sæpissime agglomerato-ternis quaternisve, superioribus sæpe alternis, solitariis et glumis distantibus quasi pedunculatis, internodiis, sæpe ipso apice, brevissime hirsutis. Interdum panicula ampla, foliosa, ramulis ultimis fere filiformibus, pendulis, foliis, reliquis minoribus, 5–10, basi cuneatis vel rotundatis (in eodem ramo) terminatis. *Spicula* plerumque nitida, lanceolata, 8–12 lin. longa, 6–12-flora, flosculis fertilibus 3–7, 1–2 vel pluribus inferioribus gemmiparis, sequentibus perfectis, his, palea superiore inferiorem superante, terminalibus 1–3 gradatim tabescentibus. *Palea* inferior basi lævis, superne nervosa, acuminata vel mucronata, interdum margine basin versus, interdum superne tenuiter fimbriata, sæpe omnino glabra; superior sæpe longior, carinis longe ciliata, sub lente valida hispidiuscula. *Squamulæ* 3, inæquales et dissimiles, duæ latiores, obtusæ, tertia lanceolata, angustior, omnes ciliatæ. *Stamina* 6, connectivo vel obtuso vel appendiculato. *Stylus* basi conico-bulbosus, infra medium 2–3-, plerumque 3-fidus in stigmata 3 pulchre plumosa. *Caryopsis* lineari-oblonga, apice styli residuo hirto coronata, "magnitudine et forma avenæ."

The hard, polished, yellowish, smooth, spinous branches of the panicle best distinguish this from *B. orientalis*. I presume that this is the species referred to above, at p. 4, as having, in 1864, furnished, during one of its periodical flowerings, food to upwards of 50,000 persons in Canara. I believe there is no doubt that this Bamboo, which Mr. Stewart says is called "Bidunguloo" in Canara, dies after perfecting its seed; but in proof of how rapidly the young plants may reoccupy the ground, I would mention that I have a plant growing in my greenhouse raised from a seed sent home by Mr. Dalzell in 1864, on which there are now 22 culms. With the exception of Wight, no. 3346, and G. Thomson, 110 and 161, nearly all the dried specimens which I have seen of this species have been collected, probably for convenience' sake, from plants bearing leaves at the end of the flowering branches, and consequently in an abnormal condition. Hence has probably arisen much of the confusion in the nomenclature of the plant indicated by the numerous synonyms quoted above.

18. B. SPINOSA, Roxb. Hort. Beng. 25 (1814); Fl. Ind. ii. 198, icon. 1964, non Nees in Linn. ix. 474. Culmo spinosissimo, florifero plerumque omnino efoliato; panicula ingente, ramosissima, spinosa, spiculis fere semper sessilibus, sæpe *curvatis*, acutis, sub 4–6-floris, 5–6 lin. longis, *coriaceis*, interdum monoicis, rhachilla *raro visibili*, per ramulos ultimos, sæpe tenues, plerumque dense *glomerato-verticillatis*, glomerulis subæquidistantibus, palea inferiore sæpissime margine *plus minus fimbriata*, in flosculis perfectis, superiorem carinis ciliatam non æquante, stylo basi conico-bulboso, cito, fere ad basin, plerumque trifido, raro forsan bifido, foliis raro ultra 6 poll. longis, subtus interdum pilosis, vaginis ore ciliatis.—Hamilton in Linn. Trans. xiii. 480, teste herb. Ham. in Wall. no. 5024; Spreng. *l. c.* ii. 112. *Arundo indica arborea*, Burmann, Thes. Zeyl. 35. *B. arundinacea*, Thw. En. Pl. Zeyl. 375, non Retz. "*Arundo bambos*," herb. Roxb. non Linn.

Hab. in India or. Bengal, Calcutta ("Behor Bans"), *Roxburgh*! *Hamilton*! *Thomson*!; Gongachora! et Goraghat! *Hamilton in Wall. Cat.* 5024! A, B; Assam ("Koto Bans"), *Jenkins*! (var. spiculis longi-

oribus); Dacca! cult. Cachar! ("Kinkoit"), *Hooker* (folia tantum); Tenasserim, Moulmeyn, 5028! *Wallich*; Mergui, *Griffith*, 327! *Helfer*, 267!; Pegu ("Yakatwa"), 8! *Brandis* (folia tantum), *M'Clelland*! v. s.

Culmi "subarborei" (*Roxb.*), dense cæspitosi, "30–50-pedales" (*Roxb.*), "100-pedales" (*Brandis*), superne incurvi, spinosissimi, ramis inferne semiverticillatis, superne alternatim distichis, vix fistulosi, duri, virido-flavi, striati. *Folia* lineari-lanceolata, 3–6 (raro 7 poll.) longa, basi plerumque attenuata in petiolum brevissimum, basi *subtumidum*, supra subglabra, subtus pallidiora et sæpe hirsuta, nervis secundariis utroque latere 4–6, plerumque inconspicuis. *Vaginæ* primum dense hirsutæ, deinde subglabræ, ore ciliis paucis caducis fimbriatæ. Internodiis culmi floriferi aphylli eis foliiferi longioribus et magis fistulosis (teste Roxb.). *Panicula* ingens, ramosissima, ramulis ultimis plerumque tenuibus, spiculis per intervalla, sæpe brevissima, dense glomerato-verticillatis. Interdum spiculæ in glomerulis, diametro 1-pollicaribus, ad basin ramulorum aggregatæ. *Spiculæ* acutæ, sæpe curvatæ, *breves*, 5–6 vel raro 8 lin. longæ, 4–6-floræ, flosculis 2-3 perfectis, sæpe monoicæ et forsan dioicæ. *Palea* inferior margine vel glabra vel fimbriata, mucronata, acuta, in spiculis masculis superiore, carinis superne ciliata, longior, in hermaphroditis brevior. *Antherarum* connectivum elongatum. *Squamulæ* 3, fimbriatæ, vix nervosæ, duæ subobtusæ, tertia lanceolata. *Stylus* plerumque cito 3-fidus, basi conico-bulbosus. *Ovarium* (immaturum) lineari-oblongum, "clavatum" (*Roxb.*). *Caryopsis* matura nunquam a me visa.

This species is best to be distinguished from *B. arundinacea* by having a paler-coloured and more striated panicle, smaller and more coriaceous spiculæ, with fewer flowers, generally smaller leaves, which are often hairy on the underside, and with the petiole sometimes remarkably swollen at the base. In some of the Tenasserim specimens the spiculæ are remarkably small; but they do not appear to differ in any other respect. Unfortunately most of the specimens I have seen are imperfect; some contain only male spiculæ, and the flowering specimens generally are unaccompanied by leaves, and *vice versâ*. Roxburgh states that "it is a middling-sized subarboreous species;" but a few lines below he says, "the height is from 30 to 50 feet;" and Dr. Brandis says it spreads all over the lower part of Pegu, in the plains and along the principal streams, and attains a height of 100 feet. Thwaites mentions that the seed of this species is eaten in Ceylon; and it was probably this species which is referred to in p. 4 as having flowered so providentially in India in 1866. The magistrate states "it was the wild thorny species only which had flowered."

19. B. ORIENTALIS, Nees in herb. Wight. 206 A, et in Linn. ix. 472 (partim). Culmo *incerte* spinoso, florifero, in speciminibus visis efoliato, *glauco-viridi, angulato* et *sulcato*, *minusque duro*, internodiis sæpe hirsutis; panicula decomposita; spiculis membranaceis, irregulariter paniculato-agglomeratis, interdum circa nodos dense verticillatis, nonnullis, glumis distantibus, distincte pedunculatis, 7–9 lin. longis, 5–8-floris; palea inferiore margine vel fimbriata vel nuda, superiorem vix subæquante, stylo basi conico-bulboso, non longe supra basin 2–3-fido; foliis (in spec. visis) 2–3½ poll. longis, petiolis plerumque hirsutis, vaginis primum hirsutis, ore longe ciliatis.—Rupr. *l. c.* 142, t. xiii. fig. 51. *B. arundinacea*, Nees in Linn. *l. c.* 475, teste Wight, hb. prop. 207!=1802!, et Rupr. *l. c.* 141, t. xiii. fig. 50, sed non Retz. et aliorum.

Hab. in peninsula Indiæ orientalis, no. 206 A!=1800!; Quilon, no. 3417! *Wight*! In planitie ad

montes Neilgherries, *Schmid.*; var. "spiculis, in glomerulis, æquo spatio distantibus spurie verticillatis," Negapatam, no. 103 !=207 !=1802 ! *Wight.* v. s.

Culmus (quoad altitudinem mihi ignotus) forsan suffruticosus, fistulosus, non solidus, glauco-viridis, internodiis ramorum sæpissime apice hirsutis, inferioribus (præcipue in culmis floriferis) tota longitudine hirsutis et sæpe uno latere sulcatis. *Folia* lineari-lanceolata, 2–3½ poll. longa, 4–5 lin. lata, apice acuta, basi subtruncata vel rotundata, attenuata in petiolum utrinque hirsutum, margine brevissime serrata, supra pilis sublongis, basi subbulbosis, sparsis, subtus pilis brevissimis hirsutiuscula, nervis secundariis utroque latere 5. *Vaginæ* superne hirsutæ, discolores, apice ciliis albis tenuibus fimbriatæ. *Panicula* decomposita, internodiis inferioribus 4–5 poll. longis, sæpissime hirsutis, angulatis, striatis, uno latere interdum profunde sulcatis, ramis paucis, simplicibus vel compositis, valde inæqualibus, 6–10-pollicaribus, ad nodos semiverticillatis, spiculis per ramos ramulosque irregulariter paniculato-agglomeratis, nonnullis distincte pedicellatis et solitariis, approximatis, erectis. Interdum, panicula nondum evoluta (*Wight*, 1802), spiculis circa nodos ramorum ramulorumque dense glomeratis, glomerulis subæquidistantibus. *Spicula* pallida, 7–9 lin. longa, 7–9-flora, flosculis 3–5 perfectis, reliquis incompletis, glumis vel bracteis 2 vel pluribus, gemmam spiculæ imperfectæ foventibus, interdum, in spiculis solitariis, longe distantibus. *Palea* inferior basi lævis, superne leviter nervosa, margine nunc glabra nunc ciliata; superior, in flosculis perfectis, carinis longe ciliata, ultra inferiorem plus minus prominens. *Squamulæ* fimbriatæ, nervosæ, inæquales, duæ obtusæ, tertia sublongior, lanceolata. *Stamina* 3 connectivo obtuso vel breviter appendiculato. *Stylus* basi conico-bulbosus, fere ad bulbum plerumque 3-fidus, interdum 2-fidus. *Caryopsis* lineari-oblonga, styli bulbo hirsuto persistente conico coronata.

I have been a little doubtful of the propriety of retaining the specific name of "*orientalis*" for this plant, as there is a specimen in herb. Wight., no. 206 B (1800), which is marked by Nees himself "*Bambusa orientalis*, mihi," and is certainly not the plant described above, but, I believe, *B. arundinacea*, Retz. However, the remainder of Wight, 1800, and also his 1802, are certainly the plant described and figured as *B. orientalis* by Ruprecht, and very probably that described by Nees also; and there may, therefore, have been some mistake in the labelling. In the structure of the spicula this species approaches very closely to *B. arundinacea*; but after an examination of the numerous excellent specimens collected by Wight in Western India at Quilon in 1835, I have no doubt that the species is a good one. I should imagine that the plant is of much dwarfer habit than any other species of the section, and is probably only about 8–9 feet high. The panicle is fistulous and soft, and almost herbaceous in appearance, and the lower portion is angled and unusually hirsute. I do not perceive any traces of thorns, and I observe that in the "Linnæa," p. 472, Nees does not describe the culm as spinous. Ruprecht, however, says the branches are shortly spinous. This may possibly, from its probable height, be *B. arundo* of Dalzell and Gibson in the 'Flora of W. India,' described at p. 299 as having "culms 8–9 feet high, and spicula 6–8-flowered," "Chiwaree" of Mahableshwar. They state that the culms of this species are thorny, and that walking-sticks are made of them.

20. B. VULGARIS, Wendl. Collect. Pl. ii. 26, t. xlvii. mala (1810). Culmo arboreo, inermi, panicula perfecta supra decomposita, ramis *striatis* vel *teretibus* et *nitidis*, ad nodos spiculas *oblongas*, *compressas*, solitarias vel paucas vel plurimas gerentibus; palea inferiore basi *subattenuata*, superne *nervosa* et margine *fimbriata*, superiore

carinis (ciliis *sæpe coloratis*) fimbriata; stylo *elongato, hirsuto*, basi simplici, *superne tantum* 2–3-fido; antheris pilis apiculatis; foliis lineari- vel oblongo-lanceolatis, plerumque utrinque glabris, venulis *transversis* conspicuis.—Roth, Nov. Plant. et Sp. 198 (1821), excl. syn. Rœm. et Sch. *l. c.* 1337 (1830); Rupr. *l. c.* 137, t. xi. fig. 47; Steud. *l. c.* 329; Griseb. *l. c.* 528; Miq. *l. c.* 417; Dalzell & Gibson *l. c.* 299. *B. Thouarsii*, Kth. "Notice sur le genre Bambusa," in Journ. de Physique, 148 (1822); Syn. Pl. Æquin. i. 252; Rev. Gram. i. 323, t. 73, 74; Enum. 131; Suppl. 356; Rupr. *l. c.* 138, t. xi. f. 40 (var. fol. lineari-lanceol. spiculis solitariis subobtusis); Steud. *l. c.* 329; Desf. Cat. 22 (1829); Rœm. et Sch. *l. c.* 1347; Nees in Linn. *l. c.* 466; Thw. Enum. *l. c.* 375, non Hassk. Pl. Jav. rar. 41. *B. surinamensis*, Rupr. *l. c.* 139, t. xi. fig. 49 (var. fol. ovato-lanc. utrinque virid. spiculis minoribus, 5–6 lin. long.); Steud. *l. c.* 329. *B. Sieberi*, Griseb. *l. c.* 528 (var. ramis nitidis vix striatis). *B. humilis*, Reich. MS. (teste Rupr.), non fide Steud. in Nomenc. *B. arundinacea*, Moon, Cat. 26 (teste Thw.), Ait. Hort. Kew. ed. 2da, ii. 316 (excl. syn. Roxb.); Link? Hort. Berol. i. 249; Sieb. Fl. Mart. no. 43; Descourt, Fl. des Antilles, iv. 281. t. 293? non Retz. *B. auriculata*, Kurz in Cat. Bot. Gar. Calc. 79, teste spec. viv. in hort. Kew. *Nastus Thouarsii*, Rasp. *l. c.* 442, et forsan *N. ririparus*, *l. c.* 458. t. viii. f. 3. *Nastus*? P. de B. *l. c.* t. xxv. fig. 3. *Arundo*, Hort. Cliff. 25!

Hab. in India utraque, forsan semper culta, nunquam certe indigena. Ind. or. Sillet ("Zice Bass" incolis), *Da Silva, Wall. Cat.* 5034!, Chittagong!, Khaji-ke-hath!, Cachar!, *Hooker et Thomson*: Bombay ("Kulluk"), *Dalzell*; Ceylon, *Colonel Walker*!; "Oonagass," alt. 1000–2000 ped. s. m., *Thwaites*, no. 3252!, (var. foliis angustis, palea inferiore acuminatissima); Java ("Tring Pitting"!), *Horsfield*; Mauritius, *Wallich in herb. Mus. Brit.*!; Borbonia et ins. St. Helena, teste *Ruprecht*; Madagascar, haud indigena, *Du Petit Thouars*; Ind. occ. Jamaica, *Dr. Distin*!, *Dr. Prior*!, *M'Nab*!; Trinidad, *Purdie*! (var. verticillis densiss.); St. Kitts, *Crueger*!; St. Domingo, *Jaeger*; Bermuda, *Munro*!; Surinam, *Weigelt*!, Guiana Gallica, *Rotheray*, no. 22!; Peru, *Mattheus*; Mexico, Brazil, fide *Grisebach*. In hortis Europæ plurimis. v. s. et v.

Culmus inermis, arboreus, fistulosus, 20–30–50-pedalis, ramosissimus, diametro 4 poll. et ultra, internodiis inferioribus 1–1½ ped. longis; spathis 6 poll. longis, intus glabris nitidis, extus pilis adpressis fuscis hirsutis, margine superne fusco-ciliatis, apiculo triangulari, 2 poll. longo, 2¼ poll. lato, basi biauriculato, utrinque hirsutissimo. *Rami* plerumque elongati, sæpe virides, opaci, striati vel teretes et nitidi, ramulorum internodiis plerumque apice hirsutis. *Folia membranacea*, lineari- vel oblongo-lanceolata, subulato-acuminata, basi interdum rotundata, interdum *inæquilatera*, cuneata, in petiolum brevem, supra scabrum vel hirsutum attenuata, nunc 1 ped. longa et 2 poll. lata, plerumque 6–10 poll. longa, 8–15 lin. lata (floralia in spec. e Ceylon 1¼–5 poll. longa, 3–5 lin. lata), margine scabra, supra glabra sed ad nervos margini adjacentes spinulis scaberrima, subtus interdum scabriuscula vel raro in junioribus inferne hirsuta, utrinque viridia vel subtus glaucescentia, nervis secundariis utroque latere 6–8, conspicuis, venulis transversis crebris, distantibus, sæpe opacis. *Vaginæ* nervoso-striatæ, ore plerumque efimbriatæ, sæpe pallidæ, primum supra medium pilis crebris brevibus vel in junioribus setulis fuscis hispidæ, demum glabræ, margine "tenuiter ciliatæ" vel nudæ, sæpe utroque latere in auriculam oblongam obtusam productæ, ligula truncata, brevi, fusco-virente, breviter ciliata. *Inflorescentia* variabilis, "scapus, vel panicula radicalis aphylla vel ramulo folioso intermixta, vel lateralis e nodis inferioribus, vel apicalis in ramulis, spiculis numerosis vel solitariis" (teste *Schultes*), in spec. a me visis, panicula plerumque aphylla, foliis raro inflorescentiam intrantibus, composita vel decomposita, internodiis glabris, nitidis, ramis ramulisque ultimis ad nodos

spiculas paucas (3–6, rarius 1–2) vel interdum plurimas densissime semiverticillato-capitatas gerentibus; ramulorum internodiis plerumque apices versus pubescentibus vel hirsutis, nunc teretibus, duris, nunc striatis vel angulatis, minus duris. *Spicula* oblongo-lanceolata, compressa, disticha, ei *Bromi* similis, 4–9–12-flora, 5–10 lin. longa, primum arcte imbricata, demum laxiuscula, rhachillæ articulis inferioribus brevissimis, conditis, superioribus elongatis, flosculo infimo unipaleaceo, neutro, margine tenuiter ciliato, reliquis, præter terminalem imperfectum, bipaleaceis et ut videtur hermaphroditis. *Palea* inferior cuspidato-acuminata, basi subattenuata, chartacea, 11–19-nervia, nervis superne sæpe prominentibus, margine, supra medium, pilis densis patentibus fimbriata; superior brevior, vel æquilonga, vel etiam longior angustior, obtusiuscula, carinis pilis *sat longis*, crebris, albidis vel *coloratis* ciliata. *Squamulæ* tenuiter membranaceæ, diaphanæ, apice pilis longis ciliatæ, inæquales, duæ obovato-oblongæ, tertia longior et multo angustior. *Antheræ* apice pilis brevibus penicillatæ. *Stylus* gracilis, filiformis, ima basi quidquam incrassatus, undique hirsutus, superne tantum 2–3-fidus, stigmatibus filiformibus, sæpe cito dilabentibus, ut stylus inde simplex esse videatur. *Ovarium* (immaturum) oblongum, apice pilosum.

The numerous specimens which I have seen of this plant have enabled me to ascertain that the large number of synonyms quoted above all belong to one species, which, indeed, considering its wide range, appears to vary less than many other species. The most remarkable varieties occur in plants cultivated in the gardens of Europe, two of which (one from the garden at Paris, and one from that of Göttingen) are figured under the name of *B. Thouarsii* by Kunth in plates 73 and 74 of his magnificent work on Gramineæ. The native country of this species is still doubtful: it is certainly naturalized in many places; but there is no reliable information as to its being actually indigenous anywhere, either in the East or the West. It is, when in flower, readily distinguished from all other species in being the only one with oblong compressed spiculæ, the lower paleæ of which are not considerably enlarged at the base, combined with a long slender style divided into stigmas at the extreme end, and stamens free at their base. A magnificent specimen of this plant is growing in the Palm-house at Kew.

21. B. Beecheyana, Munro. Culmo inermi, subarboreo; panicula *composita*, rhachi striata, ramis longis simplicibus, internodiis superioribus plerumque hirsutis, floriferis sæpe apice foliiferis; spiculis *ovatis*, plurifloris, in glomerulis subæquidistantibus paucis, vel solitariis *bractea elongata* suffultis; palea inferiore basi *latissima*, dorso glabra vel raro *subhirsuta*; stylo gracili, filiformi, superne 2–3-fido; foliis basi eximie cordatis et petiolatis, venulis transversis obsoletis vel nullis.—*B. verticillata*? Hook. et Arn. Bot. Beechey's Voyage, 254, non Willd.

Hab. in China, *Beechey*! *Sir G. Staunton in herb. Mus. Brit.*!; Quantung, Ookaisa, in sylvis, *Dr. Tate*! (var. palea inferiore dorso pubescente). v. s.

Culmus "20-pedalis," fistulosus, inermis. *Folia* (floralia tantum adsunt) lanceolata, apice setaceo-acuminata, basi *eximie cordata*, brevipetiolata, petiolo interdum *supra hirsuto*, margine serrata, 3–5 poll. longa, 6–12 lin. lata, supra glabra sed uno margine tactu scabra, subtus glabra vel hirsutiuscula, nervis secundariis vix conspicuis, utroque latere 6, venulis transversis obsoletis. *Vaginæ* sulcato-striatæ, glabræ, ore plerumque nudæ. *Panicula* (nodi 4 tantum adsunt) composita, elongata, rhachi fistulosa, *striata, vix dura*, ramis basi bracteatis, interdum sesquipedalibus, ad nodos paucis, subflexuosis (internodiis superioribus compressis, hirsutis), nunc aphyllis nunc foliosis, spiculis, in glomerulis subæquidistantibus, approximatis, vel etiam imbricatis, paucis, interdum solitariis bractea 1–2 poll. longa velatis. *Spicula ovata* vel *ovato-oblonga*, acuta vel obtusa, 7–11-flora, plerumque

6–8 lin. longa, interdum minor, rhachillæ *articulis inferioribus brevissimis*, superioribus *conspicuis*, hirsutis, flosculis 1–2 infimis et 2–3 terminalibus incompletis, reliquis bipaleaceis perfectis. *Palea* inferior 18–20-nervia, basi latissima, orbiculato-ovata, mucronata, dorso glaberrima vel raro pubescens, toto margine brevissime fimbriata; superior minor, angustior, obtusiuscula, pubescens vel hirsuta, inter carinas ciliatas binervia. *Squamulæ* 3, latæ, ovatæ, obtusæ, longe fimbriatæ, nervosæ. *Antherarum* connectivum mucrone hirsuto apiculatum. *Stylus* longus, gracilis, filiformis, hirsutus, apice 2–3-fidus. *Ovarium* (immaturum) basi attenuatum, apice rostratum.

22. B. Oldhami, Munro. Culmo inermi, *suffruticoso*, fistuloso; panicula terminali, fere *simplici*, interdum subspicæformi, rhachi angulata, striata, tactu scabrula, ramis brevissimis, spiculis *ovato-lanceolatis*, 12–13 lin. longis, flosculis 5–8 hermaphroditis; palea inferiore basi lata, glabra, margine tenuiter fimbriata; squamulis plerumque 2, raro 3; stylo hirsuto, interdum ad medium 3-fido; foliis (immaturis) parvis, lanceolatis, basi rotundatis, venulis transversis nullis.

Hab. in China, Formosa, Tamsuy, *Oldham*, no. 648! v. s.

Culmus 5–6-pedalis?, suffruticosus, fere herbaceus, pallide virens, eximie fistulosus, striatus, internodiis inferioribus 7–8 poll. longis, spathis vix 3 poll. longis, striatis, fere glabris, apiculo sub 3 lin. longo, adpresso vel refracto, ramis 1–3 ad nodos, basi bracteatis, adpressis, erectis, superioribus interdum *apice floriferis*. *Folia* (nondum evoluta) lanceolata, apice acuminatissima, basi rotundata et brevissime petiolata, sub 2 poll. longa et 6 lin. lata, supra glabra, subtus hirsuta vel demum glabrescentia, margine scabra, nervis secundariis utrinque 5–6. *Vaginæ* striatæ, superne hirsutæ et subasperæ, lateribus truncatæ et fimbriatæ, ligula inconspicua. *Panicula* in culmo *terminalis*, internodiis paucis, 3–4 poll. longis, striatis, uno latere subsulcatis, ramis, basi bracteis hirsutis velatis, brevibus vel brevissimis, internodiis paniculæ semper brevioribus, spiculas 1–4 gerentibus. Interdum rami superiores, apice, spiculas solitarias, reliquis minores, bractea suffultas, subspicatas ferunt. *Spicula* ovato-lanceolata, 8–13-flora, rhachillæ nunquam visibilis *articulis* inferioribus *brevissimis*, fere glabris, apice concavis, superioribus paulo longioribus, flosculis interdum omnibus bipaleaceis et (nisi 2–3 terminalibus) perfectis. *Palea* inferior *orbiculato-ovata*, mucronata, basi *lata*, 30 et ultra nervis venulisque transversis percursa, glabra, membranacea, margine vix conspicue fimbriata; superior *hirsuta* vel *pubescens*, paulo brevior, multo angustior, obtusa, inter carinas superne longe ciliatas 4–7-nervia. *Squamulæ* plerumque 2, *hyalinæ*, tenuimembranaceæ, *lanceolatæ*, *acutæ*, fimbriatæ, basi nervosæ, *longæ*, tertia (intermedia) plerumque (an semper?) obsoleta. *Stamina* 6, filamentis latis, connectivo antherarum mucrone longo, hirsuto, apiculato. *Stylus* basi simplex, hirsutus, interdum (non semper) ad *medium* 3-fidus, stigmatibus pulchre plumosis. *Ovarium* stipitatum, apice hirsutum, in stylum rostrato-attenuatum.

The panicle of this species bears a considerable resemblance to Roxburgh's drawing of that of *B. balcooa*, and also to the portions which I have seen of the panicle of *B. teres*. The style is also occasionally, but not always, deeply trifid; and I ought, perhaps, to have placed this species in the first section of the genus and next to *B. balcooa*. Several florets in the two spiculæ which I have examined are evidently in an abnormal state, and in some the long points of the anthers are prolonged into style-like appendages of considerable length.

23. B. Brandisii, Munro. Culmo *excelso*, usque ad 120-pedali; panicula maxima, ramosissima, ramis superioribus floriferis $1\frac{1}{2}$–2 ped. longis, gracilibus, decurvis, pendulis, spiculis in verticillis globosis, æquidistantibus, approximatis, densissime

glomeratis, spicula ovata, *brevissima*, *pauciflora*; palea inferiore apice *spinoso-acuta*, margine fimbriata, superiore apice *bifida*; squamulis plerumque 1–2, rarissime 3; stylo longo, filiformi, hirsuto, *tandem* superne 2–3-fido; foliis latis et longis.

Hab. in Ind. or. Tenasserim, Martaban, Pegu, usque ad 4000 ped. s. m., præcipue in saxis calcareis ("Kyello-wa" et "Mytsangue" incolis), *Brandis*, no. 2! v. s.

"*Culmus* 120-pedalis, circumferentia maxima 27-pollicari, striatus, inferne subnudus, prope terram ramis fasciculatis, superne foliiferis semiverticillatis, comosis, nodis inferioribus radicum annulos emittentibus, internodiis 2–2⅓ ped. longis, spathis 17 poll. longis" (*Brandis*), intus glabris, extus fuscis, superne pilis fuscis asperis, apiculo spatham longitudine superante, lanceolato-acuminato, intus basin versus pilis densis, fuscis hirsutissimo. "*Folia* magna, 10 poll. longa, 3 poll. lata, nervis secundariis 24" (*Brandis*); (in spec. a me visis) *folia* pedalia, 1½ poll. lata, lanceolata, apice acuminata, basi rotundata, utrinque glabra sed supra uno latere tactu scabra, venulis transversis obsoletis vel nullis. *Vaginæ* glabræ, ore nudæ, lateribus in auriculam obtusam rotundatam productæ. *Panicula* maxima, ramosissima, internodiis superioribus 3 poll. longis, pallidis, teretibus, nitidis, spiculis numerosissimis, in semiverticillis globosis, sæpe 9 lin. diametro, secus ramulos subæquidistantibus, sed superne approximatissimis, ramulorum internodiis apices versus incrassatis, uno latere sulcatis et hirsutis. *Spicula* 3–4 lin. longa, *ovata*, 4–5-flora, flosculis 2–3 perfectis, rhachilla inconspicua. *Palea* inferior basi *lata*, apice *spinoso-acuta*, glabra vel superne scabrula, 16–20-nervia, toto margine fimbriata; superior paulo brevior, *margine* et *carinis* fimbriata, apice bimucronata, inter carinas 2–3-nervia. *Squamulæ* variabiles, raro et tantum in flosculo infimo 3, plerumque 2 vel 1, lanceolatæ, fimbriatæ, vix nervosæ, hyalinæ. *Stamina* 6, basi libera, antheris apice penicillatis vel nudis. *Stylus* longus, basi incrassatus, hirsutus, *tandem* superne 2–3-fidus? (tametsi partitiones nunquam vidi). *Caryopsis* obtusa, styli residuo rostrata, hirsuta, 1½ lin. longa, *inferne* sulco longitudinali notata.

I have some doubt about the leaves of this plant, as two very different sorts of leaves are enclosed in the same envelopes with Dr. Brandis's excellent flowering specimens, and neither quite agree with the description given by him. I have consequently taken my description from some to which a label marked "Kyello-wa" is attached. The other leaves are remarkably unequal at the base, which would probably have been mentioned by Dr. Brandis. These latter are very thin, 14–15 inches long, and 2½ inches broad. The necklace-like flowering branches of this magnificent species are extremely striking. In many respects, especially in outward form, it approaches very closely to *Dendrocalamus flagelliferus*.

BAMBUSÆ *cognitæ steriles* (*foliiferæ tantum*), *igiturque, quoad genus, dubiæ.*

* Venuli *transversi creberrimi* conspicui, hinc folia *tessellata*.

24. B. TESSELLATA, Munro. Foliis 1–1½ ped. longis, 2–3¼ poll. latis, eximie tessellatis, an *B. reticulatæ* forma major?, Rupr. *l. c.* 148.

Hab. in China. Vidi folia segregata Theam in transitu e China involventia.

Folia membranacea, oblongo-lanceolata, *utrinque*, venulis transversis creberrimis elevatis, eximie *tessellata*, interstitiis quadratis, apice acuminata, basi inæquilatera et attenuata in petiolum brevem, supra canaliculatum, margine inferiore lævi, superiore aspero, utrinque glabra, nisi *linea tomentosa* secus costam mediam, ad latus magis evolutum, nervis secundariis utrinque 13–14, tertiariis 9–11.

I have seen only the dried leaves of this species when sewn together and in the state so largely used by the Chinese in packing their tea. I now believe that *B. reticulata*, var. *macrophylla*, of Rupr. should be referred to this species instead of to *Phyllostachys bambusoides*, as it has been at p. 36 above.

25. B. Cantori, Munro. Foliis chartaceis, 5–8 poll. longis, 1 poll. latis, utrinque tessellatis, vaginæ ciliis longissimis.

Hab. in China, Lintao! *Dr. Cantor* quoad folia, flores alieni (*B. breviflorœ*). v. s.

Folia chartacea, oblongo-lanceolata, apice spinoso-acuminata, basi vix attenuata in petiolum brevissimum, margine serrata, utrinque *glabra*, nervis secundariis utrinque 7–9, vix conspicuis, venulis *transversis creberrimis*, vix elevatis. *Vaginæ* dorso nitidæ, lateribus subhirsutæ, margine ciliatæ, ore ciliis validis longis fimbriatæ, ligula *brevi* truncata.

I have already, at p. 96, referred to the flowers which are attached to these leaves in herb. Bentham, and which I have been unable to distinguish from *B. breviflora*.

26. B. Fortunei, Van Houtte Fl. de Serres, vol. xv. (1863), t. 1535. Foliis membranaceis, *angustis*, plerumque $3\frac{1}{2}$–5 poll. longis et 4–6 lin. latis, interdum 8 poll. longis et 9–10 lin. latis, utrinque pubescentibus et tessellatis, venulis transversis sæpe *hyalinis*.—*B. picta*, Sieb. & Zucc. MS. fide herb. Zucc. sed non Lind. in Penny Cyc. (1835). *B. variegata*, Sieb. MS., Miquel in. Ann. *l. c.* 285.

Hab. in Japonia, *Kæmpfer, herb.* fol. 78!, *Bürger, in herb. Mus. Brit.*!; "Yokohama, "in sylvis pone Kanagawa, spontanea," *R. Oldham*, no. 192!; ins. Kiusiu ("Noma Saki" incolis), *Pierrot*. In hortis Europæ sæpissime cult. v. v. et s.

Culmus suffruticosus, nanus, tenuis, ramosus, teretiusculus, fistulosus, internodiis brevissimis. *Folia* lineari-lanceolata, subito acuminata, basi subrotundata, brevissime petiolata, petiolo hirsuto, margine serrata et sæpe ciliis longis fimbriata, supra pubescentia vel demum glabra, subtus pubescentia, vel in speciminibus spontaneis hirsuta, "tota longitudine, albido (in sicco flavido) lato-striato pulchre variegata," majora 8 poll., sed plurima breviora, 3–5–6 poll. longa, nervis secundariis utrinque 3–4 parum conspicuis, venulis transversis sat crebris, plerumque hyalinis, *interstitiis oblongis*. *Vagina* sulcato-striatæ, primum pubescentes, cito glabrescentes, margine ciliatæ, apice truncatæ, lateribus ciliis paucis fimbriatæ, ligula *brevissima, ciliata*.

This pretty grass appears to be quite hardy in England, and will doubtless soon become one of the most popular and commonest of variegated plants in all gardens.

** Venuli transversi *minus* conspicui, vel *obsoleti*, vel *nulli*.

(Ordo incipiens a foliis latissimis gradatim ad folia parva angustissima.)

27. B. Wightii, Munro. Foliis amplis, $2\frac{1}{2}$–4 poll. latis, 12–20 poll. longis, utrinque glabris, venulis transversis *obsoletis*, ligula *membranacea*, primum *longissima*.

Hab. in Ind. or. Courtallum, no. 1009!, Malabar, 117! 1346! *Wight*. v. s.

Folia oblonga vel oblongo-lanceolata, apice scabro-acuminatissima, basi rotundata, attenuata in petiolum 5–9 lin. longum, supra sulcatum, dorso longitudinaliter rugosum, basi valde incrassatum, ibidemque

transversim rugosum, margine lævia, utrinque *glaberrima*, supra tactu scabriuscula, nervis secundariis vix conspicuis, tota lamina 26–30. *Vaginæ* glabræ, striatæ, lævissimæ, fovea apicali emarginata, *glaberrima*, utrinque productæ, ligula sæpe 1 poll. et ultra longa, membranacea (interdum major pars superior caduca).

Wight's herbarium contains but portions of three branches of this splendid Bamboo, which, however, have the appearance of belonging to a very lofty tree.

28. B. BITUNG, Rœm. et Sch. *l. c.* 1354. "Foliis amplis, ovato-lanceolatis, 2–3¼ poll. latis, 12–18 poll. longis, subtus margineque *scaberrimis*, petiolo *hispido*."—Kunth, En. 433; Lind. Penny Cyc. (1835), non Hassk. Pl. Jav. rar. p. 42, teste Miq. Fl. Ind. Bat. iii. 417. *Schizostachyum bitung*, Steud. *l. c.* 332. *Bambusacea*, no. 12, Pl. Jungh. p. 393; Miq. *l. c.* 419.

Hab. in Java ("Bambu Bitung" incolis), ad montem Salak, *Blume*. s. v. Schultes.

"Specimen visum summitas, ut videtur, culmi, foliorum vaginis tecta, crassitie digiti, stricta. *Folia* pergamena, longe acuminata, basi breviter attenuata, supra tactu scabrida, et medio, præsertim basin versus, scaberrima, subtus glaucescentia, undique, præter nervum medium, prominentiis minutis et setulis scabra; nervis secundariis tota lamina 28, prominulis, margine denticulis scaberrima facillimeque vulnerantia, petiolo brevi, crasso, supra planiusculo et spinuloso, scaberrimo, dorso carinato et dense setoso-hispido, 3 lin. longo. *Vaginæ* crasse coriaceæ, *margine glabræ*, nervis numerosis validis striatæ, basi glabræ, sed tactu scabriusculæ, supra medium setis albidis, adpressis, haud longis, numerosis scabræ, apice iterum glabræ, *ore nudæ*, apice, ad dorsum, fovea lata, margine calloso cinctæ, ligula *brevi* truncata, extus *scabra*, margine *ciliata*."—*Schultes*.

Ruprecht and Miquel are both of opinion that this species is scarcely to be distinguished from the succeeding one, *B. apus*, and that both of them are very closely allied to *Schizostachyum Blumei*. I think it is very probable that it will prove to be the same as *Dendrocalamus flagelliferus* described in the following pages.

29. B. APUS, Rœm. et Sch. *l. c.* 1353. Foliis amplis, *lanceolatis*, 1⅓–2 poll. latis, 10–15 poll. longis, supra glabris, subtus scabriusculis, *petiolo glabro*.—Kunth, En. 433, Lind. *l. c.* *Schizostachyum apus*, Steud. *l. c.* 332.

Hab. in Java ("Bambu apus" incolis), ad montem Salak, *Blume*; "Tring apus," *Horsfield*. v. s.

Culmus, sec. *Blume*, crassitie cruris. "*Folia* chartacco-pergamena, elongato-lanceolata, longe acuteque acuminata, basi paulo tantum in petiolum angustata, supra glabriuscula, præter nervos, margini alteri adjacentes, qui spinulis minutis scaberrimi, subtus glaucescenti-viridia, attactu scabra et in foliis junioribus setulis minimis subhirsuta, nervis secundariis sub 24, minus prominentibus quam in *B. bitung*, venulis transversis crebris, parum, magis tamen quam in *B. bitung*, conspicuis, margine scaberrima, petiolo 5–6 lin. longo, subtrigono, supra quidquam convexo, dorso carinato, *glabro*, basi dilatato et ad margines callosos ibidem transversim rugoso. *Vaginæ* ut in *B. bitung*, tamen margine *breviter ciliatæ* vel demum glabræ et utrinque, ligulam versus, auricula parva, rotundata auctæ, ligula integerrima vel demum emarginata, nervosa, glabriuscula, margine tenuissime ciliata vel demum glabra."—*Schultes*.

This is certainly very close to the preceding; and the only real points of distinction seem to be the narrower leaves and glabrous petiole. There is a specimen marked

"*apus*" and "*Gigantochloa apus*" in herb. Kurz., which is, I think, distinct from the preceding, as the leaves are uneven at the base, and are much more hirsute below; the membrane below the petiole is also conspicuously fringed. I think it is very probable that Blume's *B. apus* will prove to be the same as *Oxytenanthera nigro-ciliata*, Munro.

30. B. CORNUTA, Munro. Foliis membranaceis, ovatis vel ovato-lanceolatis, 1½–2½ poll. latis, 6–9 poll. longis, utrinque glabris, margine vix asperis, petiolo glabro, vaginis glabris, lateribus, appendice *elongata*, *corniformi*, apice ciliata auriculatis, ligula brevissima.

Hab. in Java ("Tring Embon" incolis), *Horsfield*, no. 193! v. s.

Ramuli 2 cum foliis 8 tantum adsunt. *Folia* ovato-lanceolata, basin versus latissima, inæquilatera, fere e basi rotundata in apicem setaceo-acuminatum attenuata, petiolata, petiolo glabro complanato 3-lineali, utrinque glabra, margine lævia vel asperiuscula, inferiora (rami) 10 lin. lata et 2½ poll. longa, superiora 2½ poll. lata et 9 poll. longa, nervis secundariis conspicuis, utroque latere 9–13, venulis transversis crebris, distantibus, subtus conspicuis. *Vaginæ* glabræ, ore nudæ, inferne nitidæ, superne sulcato-striatæ, margine glabræ, truncatæ, latere uno vel utroque appendice corniformi, obtusa, 3 lin. longa, glabra, apice ciliis paucis longis fimbriata auriculatæ.

Two or three species of Bamboos have the curious horn-like appendages to the vaginæ described above; but in this species they are larger than in any of the others. The same native name ("Embon") is applied in herb. Horsfield to *Melocanna Zollingeri*, to which, however, the above-described leaves certainly do not belong.

31. B. RITCHEYI, Munro. Foliis lineari- vel oblongo-lanceolatis, 1½–2 poll. latis, 10–15 poll. longis, utrinque glabris, margine serratis, petiolo vix ullo, vaginis primum hirsutis, ore plerumque *nudis*, ligula *elongata*.

Hab. in Ind. or. Bombay, Kala Nuddi ("Choomaree" incolis), *Ritchie*, no. 820! v. s.

Culmus "inermis, 10–15-pedalis," internodiis, præcipue apices versus, dense sericeo tomentosis. *Folia* anguste lanceolata, apice attenuato-acuminatissima, basi leniter cuneata, sed vix petiolata, utrinque glabra, sed supra tactu asperiuscula, margine scabro-serrata, nervis secundariis utrinque sub 12, conspicuis, venulis transversis elevatis, distantibus. *Folia* novella angustiora, vix 9 lin. lata. *Vaginæ* primum pilis adpressis hirsutæ, demum glabrescentes, per totam longitudinem striatæ, margine glabræ, ore nudæ vel fibris 1–2 ciliatæ, fovea membranacea, conspicua, emarginata terminatæ, lateribus productæ, ligula valde elongata, truncata, dentata.

Ritchie states that this was found in a rivulet below the fall on the Kala Nuddi, and that baskets are made of it.

32. B. MASTERSII, Munro. *Culmo scandente*, foliis oblongo-lanceolatis, plerumque 1½ poll. latis, 10–12–13 poll. longis, utrinque, nisi ad costam basin versus, glabris, subtus glaucescentibus, margine serratis, petiolo brevissimo, sæpe hirto, vaginis præcipue *lateribus hirsutis*, margine *ciliatis*, ore ciliis *numerosis*, *longis*, subplicatis *fimbriatis*, ligula *brevissima*.

Hab. in Ind. or. Assam, Dibrooghur ("Bentibans" incolis), *Masters*, no. 1123! v. s.

"*Culmus* diffuse scandens, calamo similis" (*Masters*) (ramulorum apices tantum adsunt). *Folia* apice rostrato-acuminata, basi flavescente attenuata in petiolum, ut videtur, glandulosum, utrinque, ple-

rumque scabro-hirsutum, ima basi incrassatum, supra glabra sed punctulis minutis asperiuscula, subtus pallidiora et basin versus, ad costam, pilis sat longis hirsuta, vel tandem glabra, margine serrato-aspera, nervis secundariis utrinque 10–12, ægre a tertiariis discernendis, venulis transversis fere obsoletis. *Vaginæ* striatæ, inter strias pilis adpressis, primum hirsutæ, demum glabrescentes, margine ciliatæ, interdum biauriculatæ, ciliis longis, plicatis, numerosis fimbriatæ, ligula obsoleta.

33. B. M'Clellandi, Munro. Culmo scandente, *aspero*, foliis oblongo-lanceolatis, 12–18 lin. latis, 5–10 poll. longis, utrinque glabris, membranaceis, margine *vix asperis*, vaginis glabris, ore *nudis*, ligula brevissima, truncata, dorso hirsuta.

Hab. in Ind. or. Pegu, Rangoon, Phoungee Valley! *M'Clelland.* v. s.

Culmus gracilis, *scandens*, internodiis superne *pilis asperis*, 7 poll. longis, ramis ad nodos 3, deflexis, polyphyllis. *Folia* tenuia, concoloria, apice setaceo-acuminata, basi inæqualia, vix attenuata in petiolum brevissimum, subrugosum, *utrinque glabra*, sed supra, medio et ad alterum marginem, setulis minutis tactu aspera, nervis secundariis utroque latere 9–12, inconspicuis, venulis transversis obsoletis. *Vaginæ* striatæ, utroque latere in auriculam obtusam, brevem productæ.

Judging from its general appearance, I think it is very probable that this may prove, when its flowers are discovered, to be a species of *Cephalostachyum*.

34. B. marginata, Munro. Culmo scandente, nigrescente, *glabro*, foliis oblongo-lanceolatis, majoribus 12–14 lin. latis, $6\frac{1}{2}$ poll. longis, supra subtusque glabris, superne *pilis* sat longis, *densis*, subsericeis *utrinque marginatis*, *petiolatis*, vaginis glabris, ore *nudis*, apice *truncato subhirsutis*.

Hab. in Ind. or. Tenasserim? Daunat faucibus, alt. 5000 ped. s. m. ("Wamé" incolis), *Brandis*, no. 17! v. s.

"*Culmus* alte scandens, nigrescens," fistulosus, internodiis glabris, "ramis subsolitariis, ramosis" (*Brandis*), (in specimine a me viso) fasciculatis, deflexis, basi bracteatis, geniculatis et tortuosis, apice oligophyllis, internodiis inferioribus ramorum apice hirsutis. *Folia* setaceo-acuminata, basi rotundata, petiolo 1–3 lin. longo, glabro vel supra scabro, margine lævia, nisi apicem versus, ubi pulchre fimbriata, majora ut supra, minora vix 3 poll. longa, 5–6 lin. lata, nervis secundariis utrinque 4–7, centrali subtus rufescente, venulis transversis paucis, vix conspicuis. *Vaginæ* sulcato-striatæ, dorso carinatæ, margine, nisi ipso apice, glabræ, membrana, infra petiolum, hirsuta et brevissime ciliata terminatæ, ligula *brevi*, truncata, dorso hirsuta.

The smooth stems and curious fringe on the upper portions of the margins of the leaves distinguish this from the preceding species. Dr. Brandis says that "it is a real climber, intertwining the stems and branches of the oaks and chestnuts."

35. B. Helferi, Munro. Culmo scandente, *pilis* et *punctulis aspero*, foliis sublanceolatis, majoribus 12–14 lin. latis, 5 poll. longis, *margine uno* serratis, altero lævibus, utrinque glabris, vaginis margine *ciliatis* vel raro glabris, ore *fimbriatis*.

Hab. in Ind. or. Tenasserim, *Helfer*, no. 411! v. s.

Culmus fistulosus, internodiis 4 poll. longis, 2 lin. diametro, asperrimis, ramis brevibus, ad nodos incrassatos, membrana rugosissima circumvolutos, fasciculatis. *Folia* pergamena (siccando fere crispata), subinæquilatera, apice setaceo-acuminata, basi cuneata, vix petiolata, supra, medio et alterum marginem versus, setulis minutis aspera, nervis secundariis utrinque 6–7, ad imam basin continuis, venulis

transversis distantibus, paucis, vix conspicuis. *Vaginæ* superne sulcato-striatæ, apice truncato brevissime ciliatæ, oreque ciliis sublongis *fimbriatæ*, ligula brevi interdum ciliata.

This has a much more scabrous stem than *B. M'Clellandi*, and is, moreover, distinguished from both the preceding species by the fringe at the sides of the vaginæ. The ligula has also occasionally a long fringe.

36. B. HORSFIELDII, Munro. Culmo subscandente, vel vagante?, superne filiformi, punctulis minutis aspero, foliis lineari-lanceolatis, maximis 9–10 lin. latis, 6 poll. longis, petiolatis, utroque margine asperis, supra glabris, sed hinc et inde tactu asperis, subtus pilis brevibus hirsutis, vaginis hirsutis vel glabris, utroque latere, in auriculam corniformem, obtusam, apice ciliatam productis.

Hab. in Java, *Horsfield.* v. s.

Culmus tenuis, fistulosus, internodiis superioribus 3–4 poll. longis, asperis, tenuissimis, ramis ad nodos 2–4–5, divaricatis. *Folia* tenuia, majora ut supra, minora vix 1½ poll. longa, et 3 lin. lata, petiolo undique hirsuto, apice setaceo-acuminata, basi subflavescente cuneata, supra, medio et marginem alterum versus, scabra, nervis secundariis utrinque 5-6, venulis transversis obsoletis. *Vaginæ* sulcato-striatæ, inferiores hirsutæ, superiores margine interdum subviscido-hirsutæ, apice truncatæ, biauriculatæ, ligula brevi.

This has neither name nor number in Horsfield's collection, but appears to be a distinct species. The curious auricles of the vaginæ are similar in form to those which occur in *B. cornuta*, which, however, appears to be a tall arboreous species, whereas this is a slender creeper or twiner.

37. B. LUÇONIÆ, Munro. Culmo subscandente, superne *filiformi*, *asperrimo*, foliis lineari-lanceolatis, *angustis*, 4–5 lin. latis, 3–4 poll. longis, breviter petiolatis, margine membranaceo pallido cinctis, utrinque, nisi interdum basin versus, glabris, punctulis minutis elevatis vix asperis, vaginis subglabris, ore ciliis paucis, tenuibus, cito caducis fimbriatis, ligula *brevissima*.

Hab. in ins. Philipp. Luçonia, montibus mahaihai!, *Wilkes.* v. s.

Culmus vagans vel scandens (pars superior 3½-pedalis adest), internodiis inferioribus 4 poll. longis, asperiusculis, *superioribus* 1½ poll. longis, *asperrimis*, ramis ad nodos 4–5, brevissimis. *Folia* mucronato-acuta, basi rotundata, *albo marginata*, nervis secundariis utrinque 3–4, venulis transversis obsoletis. *Vaginæ* striatæ, inter strias paucas pubescentes vel demum glabræ, apice truncatæ.

Blanco has given short descriptions of several species of Bamboo from the Philippine Islands, but this does not agree with any of them.

38. B. AUREA, Sieb. MS. apud Miquel, Ann. *l. c.* ii. 285. "Culmo suffruticoso, foliis lanceolatis, 4–6 lin. latis, 2–3 poll. longis, margine obsolete scabrulis, cæterum utrinque glaberrimis, vaginis glabris, vix striatulis, ore semper glabris, ligula brevi, abbreviato-semirotundata, glabra, fuscula."

Hab. in Japonia, *Siebold*, spec. cult. vid. Miquel; v. cult. in hort. Kew! an eadem?

"*Rami* tenues, teretiusculi, longi, graciles, virides, ramulis ad nodos tumidos gracilibus, ⅓–½-pedalibus, 6–8,

simplicibus vel parce ramosis, flaccidis, unilateraliter fasciculatis. *Folia* breviter sed distincte petiolata, e basi acutiuscula lanceolata, acuta, membranacea, tenera, læte viridia, subtus pallidiora, nervis secundariis utrinque 3–4, ægre a tertiariis discernendis, venulis transversis obsoletis. An ob colorem foliorum emortuorum flavescentium '*aurea*' dicta?"—*Miquel.*

The plant which I have seen cultivated at Kew under the name of *B. aurea* appears to be a species of *Arundinaria* or *Thamnocalamus*. It agrees with the above description, except that the vaginæ are more distinctly striated, the transverse veinlets rather more conspicuous, and the ligule is rather elongated.

39. B. REGIA, Thomson, MS. in Brandis herb. (nomen tantum). Culmo *arboreo*, elato, foliis angustis, fere linearibus, vix 3 lin. latis, 2–3½ poll. longis, supra glabris, sed uno latere tactu asperis, subtus concoloribus, hirsutiusculis vel glabris, vaginis striatis, inter strias hirsutis, vel demum glabris, margine superne ciliatis, ore nudis.—Cat. Bot. Gard. Calc. 79. *B. siamensis*, Kurz, teste Kurz in herb.

Hab. in Ind. or. Tenasserim, ad Saluen fluv. ("Tiwa" incolis), *Brandis*, no. 12!; Siam! *Kurz*. v. s.

"*Culmus* 40-pedalis, strictus, inferne nudus, apice ramorum verticillos gerens, circumferentia 4–10 poll., internodiis nitidis, 1–13 poll. longis, annulis horizontalibus, spathis deciduis, internodia æquantibus, apiculo adpresso, lanceolato." (*Brandis*). In speciminibus a me visis *spathæ* 11 poll. longæ, basi 8 poll. latæ, vix coriaceæ, intus inferne glabræ, extus pilis brevibus, adpressis, nitidis hirsutæ, apiculo 4–5 poll. longo, utrinque hirsuto, internodiis culmi superioribus sub 4 poll. longis, flavidis, nitidis, solidis, ramulis simplicibus vel compositis et divaricatis, ad nodos paucis vel numerosis. *Folia* apice mucronato-acuta, basi rotundata vel cuneata, petiolata, margine serrata, nervis secundariis utrinque 3–4, inconspicuis, venulis transversis nullis. *Vaginæ* apice truncatæ, ligula brevissima, truncata.

Brandis says that "this is a most elegant Bamboo, on account of the regularity of the nodes," and that it is brought to Moulmeyn in great quantities, and used as handles for umbrellas. The young plant cultivated at Kew, and received, I believe, from Calcutta as *B. regia*, appears to be distinct from this species. In the Kew plant the leaves are 6 inches long and 10 lines broad, with 6 secondary nerves on each side, and the petiole inconspicuously hairy above, whereas it is quite glabrous in the Tenasserim specimens.

40. B. PYGMÆA, Miquel, *l. c.* 286. "Culmo suffruticoso, *semipedali*, solido, subtereti, ramoso, foliis dense distichis, e basi rotundata in petiolum vix ullum constrictis, lanceolatis, acutis, 5–4 lin. latis, 1–1½ poll. longis, marginibus subciliolato-scabris, subtus pubescentibus, subglaucino-pallidis, nervis lateralibus utrinque 3–4."

Hab. in Japonia ("Gin-Meitsik" incolis), *Siebold.* Colitur in horto Bogoriensi. s. v. Miquel.

"Statura pygmæa insignis, cæterum *B. aureæ* et *B. puberulæ* [*Phyllostachys nigra*, Munro] quodammodo accedens."—*Miquel.*

41. B. AUREO-STRIATA, Regel, Gartenflora, 1865, 362, t. 490. figg. 3, 4. "Caule humili (1–2-pedali), tenui, glaberrimo, nodis biannulatis, sæpe ramulos 3 breves gerentibus, ramis basi bracteis glabris vel villoso ciliatis vestitis, foliis lanceolatis vel ovato-

lanceolatis, acuminatis, basi in petiolum attenuatis, margine scabris, vaginis *glabris*, ligulis *exsertis*, truncatis, *denticulatis*, *pilosulis*."—*Regel*.

Habitatio ignota.

This is very probably a species of *Phyllostachys*.

42. B. ARGENTEO-STRIATA, Regel, *l. c.* fig. 5. "Caule glabro, 4–5-pedali, crassitie pennæ cygneæ; ramulis ad nodos biannulatos confertissimis; foliis lineari-lanceolatis, glabris, acuminatis, basi rotundatis, brevissime petiolatis, margine scabris, vaginis brevissime puberulis, ore in ligulam brevissimam, longe ciliatam excurrente."—*Regel*.

Hab. ignota.

In the drawing this bears a resemblance to *B. Fortunei*.

I have not yet observed either of the two preceding species in cultivation in England; and neither the descriptions nor the coloured figures enable me to identify either of them with any previously known species.

In addition to several of the preceding species, described from specimens collected by Dr. Brandis, and in describing which I have derived much assistance from that gentleman's careful notes made on the living plants, I have seen some specimens of his no. 6, "Wathaboot," and no 14, "Theiwa" of the Burmese; but in neither case are they sufficient to enable me to describe the plant satisfactorily; and, unfortunately, in these two instances Dr. Brandis's notes do not contain much information, nor do they quite agree with the specimens. Some of Dr. Brandis's plants belong to other genera than *Bambusa*, and will be found described in the following pages.

Many of the species, from no. 24 to 42, as well as several of the following less-known species, may very probably not belong to *Bambusa*; but, in accordance with the custom and example of most authors, I have placed under the main genus *Bambusa* all those doubtful plants which I had not strong reasons for believing to belong to other genera.

Bambusæ floriferæ, minus notæ, auctoribus inepte descriptæ.

(Ordo alphabeticus.)

43. B. AGRESTIS, Poir. Enc. viii. 704. "Culmo arboreo, durissimo, ramis inferioribus *spinosissimis*, foliis lineari-lanceolatis, parvis, glabris, petiolis longiusculis, tenuibus, panicula terminali, erecta, spiculis congestis, brevibus, paucifloris, stigmatibus 2, caryopsi oblonga."—R. et Sch. *l. c.* 1344; Kunth, Enum. 432; Rupr. *l. c.* 149; Steud. *l. c.* 330; Lindl. *l. c.* *Arundo agrestis*, Lour. Fl. Cochin., 72. *Arundarbor spinosa*, Rumph. Amb. iv. 14, t. 3. (teste Lour.) an recte?

Hab. in Cochin-China et fortasse etiam in China, *Loureiro*.

"*Culmus* lignosus, subteres, *tortuosus*, 30 ped. altus, brachii crassitie, nodis prominentibus, internodiis brevibus, intus parum vacuis, sæpe integre solidis, ramis multis, inferioribus densioribus, arcuatis, intricatis, spinis plurimis, crassis, sparsis, curvis. *Folia* et inflorescentia ut supra." *Squamulæ* (corollæ, *Lour.*) "minimæ, lanatæ."—*Loureiro*.

I think it is very probable, as stated at p. 102, that this is the same as *B. Blumeana*, Sch., or possibly *B. spinosa*, Roxb. Rumphius describes the leaves of his *Arundarbor spinosa* as having leaves 6–7 inches long and an inch broad, which does not agree with Loureiro's description of "folia lineari-lanceolata parva."

44. B. DIFFUSA, Blanco, Fl. Filip. 269. "Culmo plerumque *procumbente*, foliis ensatis, subtus *pilosis*, margine serratis, floribus dense distichis, spicatis, stigmatibus 3, villosis, *semine magno, ciceriformi*, testa 4-lineata."—Steud. *l. c.* 331; Miq. Fl. Ind. Batav. iii. 421.

Hab. in ins. Philipp., *Blanco*.

In the size of the fruit this agrees very well with *Schizostachyum acutiflorum*, of which it may be only a variety with leaves hairy below.

45. B. LINEATA, Munro. "Internodiis longis, ultra 2 poll. crassis, externe albicantibus, interpositis *striis viridibus* longitudinalibus (in inferioribus viridis color frequentior), articulis inferne copiosioribus, pilis vaginarum prurientibus raris; ramulorum summum aliquando terminatur in spicam longam, ex nodosis verticillis constantem, et compositam ex paleaceis et duris squamis, instar aristæ obtusæ, erectis."—*Leleba lineata*, s. *virgata*, Rumph. *l. c.* iv. 2; Rœm. et Sch. *l. c.* 1346.

Hab. in ins. Ternate et Celebe, in Amboina exotica, *Rumph.*

46. B. LONGINODIS, Miq. *l. c.* 418. "Culmis majoribus 2 digitos crassis, internodiis $3\frac{1}{2}$–4 ped. longis, externe pallide virentibus, rugosisque, nodis inferioribus, ramulos abortivos, breves, firmos, spinas mentientes et vulnerantes emittentibus, foliis illis *B. atræ* similibus, sed glabrioribus nec hirtis, attamen scabris et rugosis, floribus verticillatis ut in *B. tenui*."—*Arundarbor spiculorum*, s. *Bulutuy*, Rumph. *l. c.* iv. 7.

Hab. in Amboina, Manipe, et Java, *Rumph.*

"*Culmi* valde stoloniferi, *crassum* formant *fruticem*, cujus trunci interni, majores, ultra 2 digitos crassi, externi vero vix digiti minoris crassitie, tenuiores et glabriores. Textura adeo dura ut, si majori cultro cædatur, ignis scintillæ exsiliant."

This is included in Loureiro's *Arundo tabacaria* by Poiret, Schultes, and others, but, I think, erroneously; for Loureiro does not mention the spinous lower joints, and says that his plant is slender and scabrous all over.

47. B. LUMAMPAO, Blanco, *l. c.* 270. "Culmo *erecto, inermi*, spiculis in spicam compositam, interruptam confertis, fasciculis rotundatis vel elongatis, ultra 50-spiculatis, paleis vix ciliatis, stylo solitario, stigmatibus 2 brevissimis."—Steud. *l. c.* 331; Miq. *l. c.* 421.

Hab. in ins. Philipp., *Blanco*.

Sticks from this plant are stated to be commonly sold at Manilla.

48. B. MITIS, Poir. Enc. viii. 704. "Culmo *inermi*, omnino æquali, 40-pedali, ramis inermibus, numerosis, foliis *majusculis*, lanceolatis, *amplexicaulibus*, panicula simplici. erecta, coarctata, spicis longis, imbricatis, stylo in stigmata 3, longa, villosa trifido." —Rœm. et Sch. *l. c.* 1351; Kunth, *l. c.* 432; Rupr. *l. c.* 150; Steud. *l. c.* 330: Lindl. *l. c.* (1835), non Blanco. *Arundo mitis*, Lour. *l. c.* 73 (excl. syn. Rumph.).

Hab. in Cochin-China ("Cay-mo-ho," incolis), culta, vix frequens in arvis et sepibus.—*Loureiro.*

"*Culmus* lignosus, teres, nodis distantioribus vix prominentibus." "In tenuissimas tænias secta uti solent ad texendos pileos, cistas et diversa ac pulchra vascula." *Loureiro.*

49. B. MONOGYNA, Blan. *l. c.* 268. "Foliis ensiformibus, utrinque rigide et breviter pilosis, margine hamulosis, petiolis pilosis, spiculis dense spicatis, plurifloris, gluma uniflora, corollæ petalis 2 parvis, antheris majusculis, stylo 1, stigmatibus 2."—Steud. *l. c.* 331; Miq. *l. c.* 420.

Hab. in ins. Philipp., *Blanco.*

50. B. MULTIPLEX, Raeusch; Rœm. et Sch. *l. c.* 1350. "Culmo inermi, fistuloso, 12-pedali, pollicem crasso, *multiplici*, internodiis longissimis, foliis lanceolato-linearibus, 6 poll. longis, *glabris*, *amplexicaulibus*, *fusco-viridibus*, spicis terminalibus, paucis, erectis, longis, interruptim *verticillos* spicularum *subulatarum* circa pedicellum communem, sessilem gerentibus, stigmatibus 3 sessilibus, longis, plumosis, reflexis, caryopsi oblonga."—Kth. *l. c.* 432; Rupr. *l. c.* 150; Lind. *l. c.*; Steud. *l. c.* 330. *Arundo multiplex*, Lour. *l. c.* 73 (exc. syn. Rumph.).

Hab. in Cochin-China, locis cultis provinciarum borealium ("Cay-hop" incolis), *Loureiro.* "An una vel altera varietatum *Lelebæ* a Rumphio descriptarum?"—*Schultes.*

In many respects this approaches in description to *B. nutans*, Wall.

51. B. PUNGENS, Blan. *l. c.* 270. "Gemmis ramorum acutis, rigidis, foliis anguste ensiformibus, subtus glabris, supra asperrimis, margine minutissime hamulosis, petiolis pilosissimis, staminibus 6, ovario basi pilorum fasciculo obsito, stylo magno, stigmate ramoso vel ad medium bipartito."—Steud. *l. c.* 331; Miq. *l. c.* 421.

Hab. in ins. Philipp., *Blanco.*

52. B. TENUIS, Munro. "Culmo 15–16-pedali, *duritie arundinis Europeæ*, extus *glabro*, spathis pilis tenuissimis, pruritum excitantibus obsitis, internodiis inferioribus 2 ped., superioribus 3–3½ ped. longis, foliis superioribus 13–14 poll. longis et 4 poll. latis, tenuibus, petiolis pilis pungentibus hirsutis, capitulis verticillatis, per interstitia distinctis."—*Arundarbor tenuis* (*Leleba alba*, Rumph. *l. c.* iv. 1, t. 1); Rœm. et Sch. *l. c.* 1346.

Hab. in Macassara circa domus et areas plantata, Ceramæ ore occidentali, *Rumphius.*

"*Culmus* ad nodos inferiores viridis, ad superiores pallide virens et albicans, detruncatus et siccatus album exhibet colorem, tertia ab inferiore parte ramuli multi erecti 7–12 poll. longi, arcte incumbentes, in superioribus internodiis ramuli ac folia sensim sunt majores magisque sese extendunt. *Folia* 4–5 in ramulo, inferiora palmam longa, pollicem lata, superiora ut supra. In adulta longus erigitur culmus

in capitula verticillata per interstitia distinctus; quivis verticillus compositus est ex diversis apicibus et acutis capitulis instar avenæ obtusæ, erectis, in culmi summo semper frequentioribus."—*Rumph.*

Kunth includes this as a synonym of *B. verticillata*, Blume (*Gigantochloa verticillata*, Munro); and Loureiro considers it to be his *Arundo multiplex* (*B. multiplex*, Poir.); but it appears to me to be very doubtful whether it really belongs to either species, being distinguished from the first by its shorter and much softer stem, and from the last by the size of its leaves. *B. Beecheyana* bears a greater resemblance to Rumphius's drawing than *G. verticillata* does.

Bambusæ minus notæ, steriles, foliiferæ tantum.

53. B. AMAHUSSANA, Lindl. *l. c.* no. 25. "Culmo pollicem crasso, *adeoque duro* ac *Arundarbor spinosa*, vix recto, internodiis brevibus, spathis pilosis et rugosis, foliis instar *Lelebæ* vel paulo latioribus, exceptis inferioribus quæ minora sunt, tenuia, glabra nec pilosa."—*Leleba amahussana*, Rumph. *l. c.*; Rœm. et Sch. *l. c.* 1346; Rupr. *l. c.* 146.

Hab. in Amboina ad pagum Amahussa, Manipa, *Rumphius*.

Rumphius adds that the wood of this is very thick, and that the Chinese use the leaves for packing their rice in.

54. B. ARISTATA, Lodd., Lindl. *l. c.* no. 16. "Culmo tenui, glabro, inermi, *nodis* primum *farinosis*, foliis glaberrimis, basi in petiolum brevem attenuatis, vaginis pubescentibus, fimbriatis, ligulis ciliis longis, validis fimbriatis."

Hab. in Ind. or., *Lindley*.

55. B. ATRA, Lindl. *l. c.* no. 22. "Culmo ex nigro viridi usque ad verticem, internodiis ad summum $2\frac{1}{2}$ poll. [an pedes?] longis, foliis 13–16 poll. longis, 2–$3\frac{1}{2}$ poll. latis, maxime sinuosis et *nervosis*, superne ex viridi nigricantibus, inferne griseis. Substantia lignosa, non torqueri potest, *Lelebæ albæ* (*B. tenuis*) instar, sed frangitur et facile finditur."—*Leleba nigra*, Rumph. *l. c.*; Rœm. et Sch. *l. c.*; Rupr. *l. c.* 145.

Hab. in Amboina, *Rumphius*.

56. B. BLANCOI, Steud. *l. c.* 331. "Culmo inermi, foliis ensiformibus, utrinque rigide breviterque pilosis, margine minutissime serratis, petiolis per totam longitudinem pilosis."—Miq. *l. c.* 421. *B. mitis*, Blanco, *l. c.*, non aliorum.

Hab. in ins. Philipp., *Blanco*.

57. B. FERA, Miq. *l. c.* 418. "Culmis usque 30-pedalibus, superne nutantibus, inermibus; ad nodis sæpe curvatis, internodiis ad nodos brevisulcatis, 1–$1\frac{1}{2}$-pedalibus, foliis 6–10 poll. longis, digitum latis, glabris, viridibus, subtiliter striatis."—*Arundarbor feræ* species prima s. *Bulu Swangi*, Rumph. *l. c.* iv. 16, tab. iv. (folia tantum depicta); "*anne B. vulgaris*?" (Miq.).

Hab. in Amboina, *Rumphius*.

58. B. LEVIS, Blanco, *l. c.* 270. "Foliis ensiformibus, supremis magnis, subtus *molliter lanatis*, supra breviter et *rigide pilosis*, margine nervoque medio supra minutissime hamulosis, petiolis totis pilosis."—Steud. *l. c.* 331; Miq. *l. c.* 421.

Hab. in ins. Philipp., *Blanco*.

59. B. LIMA, Blanco, *l. c.* "Foliis lanceolatis, angustis, *pilis rigidis* utrinque asperis, margine minutissime hamulosis, petiolis *apice pilosis*, cæterum glabris."—Steud. *l. c.*; Miq. *l. c.*

Hab. in ins. Philipp., *Blanco*.

60. B. MAXIMA, Poir. Enc. viii. 704. "Culmo maximo 80–100-pedali, crassitie cruris, internodiis tripedalibus, valde inanibus (ligno vix ½-poll.), externe quidpiam rugosis, stipitibus rectissimis, ad verticem usque simplicissimis, ramulis terminalibus paucissimis, foliis fere ut in *B. aspera* sed paulo minoribus. *Arundarbor aspera, farina* et crassitie ligni abunde diversa."—Rumph.; Rœm. et Sch. *l. c.* 1352 (excl. syn. Lour.); Kth. *l. c.* 432; Rupr. *l. c.* 152; Steud. *l. c.* 331. *Arundarbor maxima* seu *Bulu Sammet*, Rumph. *l. c.* iv. 12.=*Bambusa excelsa*, Miq. *l. c.* 418. *Arundo maxima*, Lour. *l. c.* 74, "spinis densissimis horrida," differe videtur.

Hab. in Amboina, in summis montibus; Manipa, Kelanga et Cerama; Java, in montibus, *Rumphius*.

This may possibly, as stated at p. 124, be the same as *Gigantochloa verticillata*, Munro.

61. B. PICTA, Lindl. *l. c.* no. 24. "Internodiis usque 4 ped. longis, 2 poll. crassis, substantia minorem pennam crassis, siccatis albissimis, foliis angustis, vix hirsutis. Ex hac formantur baculi, 4–4½ ped., albi vel variis figuris exusti."—*Leleba picta*, Rumph. *l. c.*; R. et Sch. *l. c.* 1346; Rupr. *l. c.* 146.

Hab. in Cerama, Kelanga et Celebe inss., *Rumphius*.

62. B. PRAVA, Lindl. *l. c.* no. 23. "Culmis ingentes sylvas formantibus, *Lelebis* reliquis crassioribus, sed tenuioris substantiæ, admodum fragilibus, foliis omnium latissimis, 14–18 poll. longis, ultra palmam latis, sinuosis et nervosis, superne pallide viridibus, inferne griseis, pungentibus, spinulis frequentissimis hirtis, unde vix tractabilia sunt ob pruritum quem excitant."—*Leleba prava*, Rumph. *l. c.*; Rœm. et Sch. *l. c.* 1346 Rupr. *l. c.* 145.

Hab. in Amboina, vulgatissima, *Rumphius*.

63. B. STRIATA, Loddig., Lindl. *l. c.* no. 19. Culmo inermi, tenui, 20-pedali, nitido flavo, striis viridibus, foliis angustis, in petiolum attenuatis, utrinque glabris, subtus glaucescentibus, vaginis pilis brevissimis paucis subhirsutis.

Hab. in China, in Anglia sæpe culta, *Loddiges*.

64. B. TABACARIA, Poir. Enc. viii. 705. "Culmo *tenui*, rectissimo, æqualissimo, solido, *aspero*, ramoso, internodiis longissimis, durissimis, tenacissimis, *scabris*. Ex illis lævigatis fiunt fistulæ tabacariæ pulchræ."—Lour.; Rœm. et Sch. *l. c.* 1351;

Kth. *l. c.* 432; Rupr. *l. c.* 151; Steud. *l. c.* 331. *Arundo tabacaria*, Lour. *l. c.* 74 (excl. syn. Rumph.).

Hab. in Cochin-China ("Oung-thaong" incolis), *Loureiro*.

65. B. TEBA, Miq. *l. c.* 418. "Culmo vix alto, ab inferiore parte usque ad summum *spinosis* undique armato *ramis*, crassitie pedis, internodiis 1½-pedalibus, extus glabris et politis, substantia omnium crassissima, foliis 6–7 poll. longis, *poll. latis*, subtiliter striatis, tenuibus, *glabris*, superioribus minoribus, 4–4½ poll. longis."—Rumph. *Arundarbor spinosa*, s. *Bulu Baduri*, *Teba Teba*, Rumph. *l. c.* iv. 14, t. 3; R. et Sch. *l. c.* 1344; Rupr. *l. c.* 149.

Hab. in Amboina, Cerama, Manilla, Java, China australi, *Rumphius*.

"Ex ipsius truncis quam ex omnibus ramis, sæpissime aphyllis, horridæ progerminant spinæ, retrorsum incurvatæ. Rami inferiores sæpe procumbentes, hamis et spinis armati."

I have already stated, at p. 102, that it is possible that this may be the same as *B. Blumeana*; but that certainly does not ever appear to be so "horridly spinous" as this species is described to be.

66. B. TEXTORIA, Blanco, *l. c.* 270. "Culmo erecto, foliis ensiformibus, supra glabris, subtus margineque scaberrimis."—Steud. *l. c.* 331; Miq. *l. c.* 421.

Hab. in ins. Phillipp., *Blanco*.

67. B. VASARIA, Munro. "Culmo elegantissimo et politissimo, 36–50-pedali, internodiis 2–3 poll. longis, ultra pedem crassis, viridibus, glabris, ligni substantia vix minorem digitum crassa, surculis omnibus ad ortum vaginis rugosis obductis, atque pilis rarioribus caducis hirtis, foliis inferioribus minimis, 6–7 poll. longis, 1 poll. latis, superioribus 13–14 poll. longis, in surculis 17 poll. longis, 1½–2 poll. latis, subtiliter nervosis, tenuibus, margine asperis, in junioribus fruticibus subtus parum lanuginosis, in vetustioribus glabris."—Rumph. *Arundarbor vasaria* s. *Bulu Java*, Rumph. *l. c.* iv. 8; Rœm. et Sch. *l. c.* 1341 (in obs. ad *B. arundinaceam*); Rupr. *l. c.* 142.

Hab. in Amboina, Cerama, Molucca, Java, *Rumph.*; an Java ("Tring Djawa"! incolis)? *Horsfield*. v. s.

I have, at p. 100, quoted this as a probable synonym of *B. balcooa*, but I do not feel certain of its identity. Schultes has quoted it under *B. arundinacea*; and Miquel thinks it may be the same as *B. vulgaris*. Loureiro quotes it as a synonym of his *Arundo bambos*, which, however, he describes as having "folia parva." Some specimens, in leaf only, in Horsfield's herbarium, marked "Tring djawa," agree very well with the preceding description. Miquel, *l. c.* 416, identifies "Djawa" with *B. verticillata*, Blume.

Bambusæ species auctorum generibus alienis redactæ.

B. ABYSSINICA, Rich.	= *Oxytenanthera abyssinica*, Munro.
B. ALPINA, Bory	= *Nastus borbonicus*, Gmel.
B. AMPLEXIFOLIA, Rœm. et Sch.	= *Guadua amplexifolia*, Presl.

B. BACCIFERA, Roxb. =*Melocanna bambusoides*, Trin.
B. BARBATA, Trin. =*Nastus barbatus*, Rupr.
B. BIFOLIA, Sieb. =*Phyllostachys bambusoides*, Sieb.
B. CAPITATA, Trin. =*Guadua ? capitata*, Munro.
B. CHUSQUE, Poir. =*Chusquea scandens*, Kth.
B. DICHOTOMA, Don (nomen tantum) =*Phyllostachys nigra ?*, Munro (teste Rupr.).
B. DISTORTA, Nees ab Es. =*Guadua distorta*, Rupr.
B. DUMETORUM, Hance =*Schizostachyum dumetorum*, Munro.
B. ELEGANTISSIMA, Hassk. =*Beesha elegantissima*, Kurz.
B. FAX, Poir. =*Beesha fax*, Rœm. et Sch.
B. GLAUCIFOLIA, Ruprecht =*Schizostachyum glaucifolium*, Munro.
B. GUADUA, Humb. et Bonp. =*Guadua angustifolia*, Kth.
B. KUMASACA, Zoll. =*Phyllostachys kumasaca*, Munro.
B. LATIFOLIA, Humb. et Bonp. =*Guadua latifolia*, Kth.
B. METAKE, Sieb. =*Arundinaria japonica*, Sieb. et Zucc.
B. MITIS, Hort. non Poir. =*A. japonica*, Sieb. et Zucc.
B. NIGRA, Loddig. =*Phyllostachys nigra*, Munro.
B. NIGRO-CILIATA, Büse =*Oxytenanthera nigro-ciliata*, Munro.
B. PANICULATA, Willd. herb. =*Nastus borbonicus*, Gmel.
B. PARVIFLORA, Rœm. et Sch. =*Arthrostylidium maculatum*, Rupr.
B. PSEUDOARUNDINACEA, Steud. =*Gigantochloa verticillata*, Munro.
B. PUBERULA, Miq. =*Phyllostachys nigra*, Munro.
B. RETICULATA, Rupr. =*Phyllostachys bambusoides*, Sieb.
B. RUSCIFOLIA, Sieb. MS. =*P. kumasaca*, Munro.
B. SCANDENS, Blume =*Dinochloa tjankorreh*, Büse.
B. SCRIPTORIA, Dennst. =*Beesha Rheedii*, Kth.
B. STRICTA, Roxb. =*Dendrocalamus strictus*, Nees.
B. TAGOARA, Nees ab Esen. =*Guadua tagoara*, Kunth.
B. THOUARSII, Hassk., non Kunth. =*Gigantochloa atter*, Kurz.
B. TRINII, Nees =*Guadua Trinii*, Rupr.
B. VERTICILLATA, Willd. =*Gigantochloa verticillata*, Munro, test. hb. Willd.
B. VIRGATA, Trin. =*Guadua virgata*, Rupr.

XII. GIGANTOCHLOA.

Kurz, MS. (nomen tantum in herb.). *Bambusæ*, sp. auct. *Arundarbor* sp., Rumph.

Spicula multiflora, sursum deorsumque imperfecta, vel ovata, teres, vel oblonga, compressa, elongata, rhachilla nunquam conspicua, plerumque fere obsoleta. *Glumæ* et *paleæ* ut in *Bambusa*. *Squamulæ* abnormales, in *G. heterostachya* plerumque 3, in reliquis 1–2, sæpe abortu deficientes. *Stamina* 6, filamentis *monadelphis*, in tubum primum brevem, cito elongatum, paleis vix breviorem connatis, antheris *mucrone hirsuto* apiculatis. *Stylus* filiformis, hirsutus, longus, basi incrassatus, *exsertus*, apice tantum 2–3-fidus. *Stigmata* brevia, revoluta, pilosa. *Ovarium* apice hirsutum vel hirsutissimum, oblongum ?, interdum rostratum. *Caryopsis* ignota.

Gramina arborea in insulis Java et Malacca crescentia. Inflorescentia panicula composita vel decomposita, culmo vel ramis terminalis, ramulis foliiferis intermixtis, spiculis in verticillis nunc plurimis, nunc paucis, vel etiam solitariis, primum bractea longa, apice foliacea, interdum diutius persistente stipatis.

This genus can only be said to differ essentially from *Bambusa* in having the filaments of the stamens united into a delicate monadelphous tube.

Conspectus Specierum.

Spiculæ homomorphæ, 3–4 lin. longæ. Panicula supra decomposita. Folia basi attenuata, petiolo glabro. Vaginæ subglabræ	1. *G. verticillata.*
Spiculæ homomorphæ, 4–6 lin. longæ. Panicula bis composita. Folia basi rotundata, petiolo hirsuto. Vaginæ hirsutæ	2. *G. atter.*
Spiculæ dimorphæ, fertiles compressæ, 12–15 lin. longæ	3. *G. heterostachya.*

1. G. VERTICILLATA, Munro. Culmo arboreo, excelso, internodiis apice glabris vel scabris, raro primum farina cito decidua tectis, panicula supra decomposita, ramis interdum longissimis, foliis basi attenuatis, plerumque glabris, subtus glaucescentibus, nervis secundariis vix conspicuis, vaginis plerumque glabris.—*G. maxima*, Kurz, in herb. *Bambusa verticillata*, Willd. Spec. ii. 245 (1797) (excl. syn. Lour. et Rumph.), teste hb. Willd. no. 7007 !; Rœm. et Sch. *l. c.* 1346, sub obs. 2 ad spec. e Blume; Hassk. Pl. Jav. rar. 40, non Rupr. nec Nees. *B. pseudoarundinacea*, Steud. *l. c.* 330. *Bambusacea*, no. 17, Miq. *l. c.* 420, forsan *Arundarbor maxima*, Rumph. *l. c.* iv. 12=*B. excelsa*, Miq. *l. c.* 418.

Hab. in Java, *hb. Willd.* 7007 ! *herb. Mus. Brit.* ! *a Thunberg* ("Tring ater" incolis), *Horsfield* ! no. 647 ! 3479, *Zollinger*; Buitenzorg ("Andoong Kekens"), var. β. *minor* (Kurz) (internodiis hirsutioribus, verticillis majoribus, rhachi fistulosa); hort. Bogor. ("Andong Kitzil" !) ("Andong Bezaar" !), *Kurz.* v. s.

Culmus elatus, "80–100-pedalis, ad verticem usque simplicissimus, ramulis terminalibus paucissimis" (si *Arundarbor maxima*, Rumph., eadem est). (In speciminibus visis) internodiis floralibus 3–6 poll. longis, plerumque subsolidis, glabris, raro in var. β *striatis* et fistulosis, interdum apice farina albida cito caduca tectis. *Folia* plerumque 7–12 poll. longa, ¾–1¾ poll. lata, minora 3–4 poll. longa, 6–8 lin. lata, lanceolata, acuminata, basi attenuata in petiolum glabrum, vix longum, margine argute serrata, supra glabra, sed uno latere scabra, subtus glaucescentia, in junioribus hirsuta, in vetustioribus glabra, sed interdum costam versus pilis paucis stipitatis subhirsuta. *Vaginæ* ore truncatæ, primum scabriusculæ, demum glabræ, margine vel glabræ vel raro (in Zoll. 647) ciliatæ, ore nudæ, ligula abbreviata, truncata, apice ciliata. *Panicula* supra decomposita, ramis plerumque ramulosis, rhachi plerumque glabra, subsolida, ramis vel ramulis ultimis tenuibus, sæpe bipedalibus et ultra, horum internodiis superioribus uno latere sulcatis et hirsutis, spiculis per interstitia ½–1–3-pollicaria verticillato-glomeratis, "spiculis nunc paucis 2–4, quin hinc inde solitariis, bracteis longissimis apice foliaceis stipatis, nunc plurimis, 12–30, aggregatis." (*Steud.*). *Spicula* raro ultra 4 lin. longa, ovata, subacuta, sub-6-flora, flosculis 2–4 perfectis, rhachilla obsoleta, flosculis inferioribus unipaleaceis, brevioribus, margine minute ciliatis, superioribus sensim longioribus, sed angustioribus, longius ciliatis. *Palea* inferior multinervosa, apice breviter mucronato-acuta; superior subbrevior, angustior, inter carinas pilis sat longis ciliata, 3–4–5-nervia, apice interdum bimucronata. *Squamulæ* variabiles, lanceolatæ, apice fimbriatæ, 3 plerumque in flosculo supremo fertili tantum visæ, in flosculis

reliquis 1–2 reperiuntur, hæ semper paleæ inferiori oppositæ. *Stamina* 6, basi monadelpha, antheris mucrone plus minus hirsuto terminatis. *Stylus* brevis, basi incrassatus, superne, ut videtur, bifidus, sed forsan trifidus. *Ovarium* (immaturum) apice hirsutissimum.

This species appears to be a loftier plant than the following, and to have a much more compound inflorescence; and the spicules also are rather shorter; but the leaves appear to me to afford the best marks of distinction. Kurz is probably quite correct in identifying Rumph's *Arundarbor maxima* with this plant; but I have felt bound to adopt Willdenow's specific name as the first published. Willdenow's plant was kindly forwarded by Dr. Garcke for my inspection from Berlin, so that there is no doubt of its identity. Willdenow had only seen one flowering branchlet, sent by Thunberg, and therefore describes it as having "spica terminalis simplex." His locality of India is, of course, wrong—as Thunberg was never in India, ordinarily so called.

2. G. ATTER, Kurz, MS. (nomen tantum) in herb. Culmo erecto, 40-pedali, internodiis 1–1½ ped. longis, ad basin et apicem *albido strigoso tomentosis*, foliis basi rotundatis, vel rarissime subattenuatis, subtus hirsutis, petiolatis, petiolo *hirsuto*, nervis secundariis subtus conspicuis, vaginis pilis sæpe *atris* hirsutis, panicula bis composita, spiculis sub 6 lin. longis.—*Bambusa Thouarsii* β. *atter*, Hassk. Pl. Jav. rar. 41, non Kunth. *B. verticillata*, Miq. *l. c.* 416, partim, sed non Willd.

Hab. in Java, *Horsfield*! Buitenzorg ("B. atter Bezaar") ("B. taman") (var. rhachi hirsutiss.), *Kurz*. v. s.

Culmus apice ramosus, internodiis glabris, viridibus, apice farinosis, 1½–2 poll. crassis, spathis ovatis, subpedalibus, intus glaberrimis, extus densissime nigro strigosis, apice, lateribus undulato-fimbriatis, apiculo lanceolato, "reflexo," lanceolato-acuminato, 4 poll. longo, utrinque pilis nigris hirsuto. *Folia* lanceolata, apice fere setaceo-acuminata, basi rotundata, petiolo complanato, utrinque scabro-hirsuto, margine argute serrata, 7–13 poll. longa, 9–20 lin. lata, supra scabriuscula, subtus hirsuta et sæpissime scabra, nervis secundariis utrinque 8–10, conspicuis, venulis transversis elevatis. *Vaginæ* sulcato-striatæ, striis pilis vel nigris vel pallidioribus hirsutæ, vel pilorum residuis scabræ, marginibus longe fimbriatæ, fovea infra petiolum margine fimbriata, ore nudæ vel uno latere rarissime fimbriatæ, ligula subelongata, truncata, dorso hirsuta, margine interdum longe fimbriata. *Panicula* bis composita, ramo vel culmo? terminalis "6 ped. longa," *Hassk.* (pars superior 3 ped. longa adest in hb. Horsfield), internodiis (visis) 4–5 poll. longis, teretibus, scabris, apice pruinosis, ad nodos 3 ramos 2–3-nos, inæquales, 5–10 poll. longos, gerentibus, pars superior simplex, nutans, verticillato-spicata, verticillis 3–2–½ poll. distantibus, verticillis rhachi centrali plurispiculatis, in lateralibus 3–5–7 spiculis, internodiis ramulorum striatis, subhirsutis, uno latere sulcatis. *Spicula* ovata, subobtusa, 6 lin. longa, 6–7-flora, flosculis 2–3 superioribus unipaleaceis, 3 sequentibus perfectis, terminali vel ad pedicellum brevem redacto, vel unipaleaceo, palea reliquis simili, paleis infecrioribus dorso puberulis, superioribus, apice subobtusis, pilis penicillatis. Reliqua, *Squamulæ*. *Stamina*, *Stylus*, et *Ovarium*, nullo modo a *G. verticillata* discrepant.

Kurz, in his notes, identifies this species with *B. aspera* and *B. bitung*, Rœm. et Sch.; but the latter is described as having much longer, and the former much more glabrous leaves.

3. G. HETEROSTACHYA, Munro. Culmo gracili, 30-pedali, internodiis floriferis inferioribus apice scabris, superioribus nitidis, glaberrimis, foliis fere lineari-lanceolatis,

basi rotundatis, utrinque glabris, sed tactu asperiusculis, nervis secundariis inconspicuis, vaginis compressiusculis, glabris, panicula composita, spiculis dimorphis, fertilibus compressis, plurifloris, sæpe 12–15 lin. longis.—*Bambusa diversistachya*, Munro, in herb. T. C. D.

Hab. in Malacca, "prope Ayer Punas, circa domum," *Griffith*. v. s.

Culmus arboreus, 30-pedalis, fistulosus (internodiis floriferis tantum visis). *Folia* angusta, setaceo-acuminata, basi rotundata vel attenuata, petiolata, petiolo glabro, margine argute serrata, plerumque 8–11 poll. longa, 9–12 lin. lata, utrinque glabra, nisi interdum pili pauci subtus ad costam sparsi, nervis secundariis utrinque 4–6, ægre a tertiariis discernendis, venulis transversis obsoletis. *Vaginæ* glabræ, utrinque productæ, ore nudæ, ligula elongata, truncata, glabra, interdum longe ciliata. *Panicula* vix decomposita, terminalis, internodiis teretibus 4–6 poll. longis, inferioribus apice scabris, superioribus gradatim glabrescentibus et nitidis, ramis inferioribus ad nodos plerumque 3, interdum plurimis, nunc floriferis tantum, nunc foliiferis superne floriferis, apice nutans et simpliciter verticillato-spicata, ramis approximantibus, brevibus, subdensifloris, spiculis secus ramos fasciculato-verticillatis, vel sæpe solitariis, plurimis cylindricis acutis, angustis, incompletis, vix 9 lin. longis, paucis oblongis, compressis, 12–16 lin. longis, et 4 lin. latis, *bromiformibus*. *Spicula* fertilis 11–13-flora, flosculis omnibus, nisi 2–3 terminalibus tabescentibus et forsan infimo, bipaleaceis, hermaphroditis, rhachillæ articulis superioribus plus minus conspicuis. *Palea* inferior valde acuminata, margine et dorso glabra, superne immerse nervosa; superior multo angustior, vix brevior, sæpe hirsuta, $6\frac{1}{2}$ lin. longa, carinis inconspicue fimbriata. *Squamulæ* 3, oblongæ, longe fimbriatæ. *Stamina* 6, monadelpha, antheris mucrone *hirsuto* vel *penicillo pilorum* apiculatis. *Stylus* longus, hirsutus, superne bifidus. *Ovarium* (immaturum) apice hirsutissimum, longe rostratum.

This has a very different appearance from the two preceding species. The perfect spicula has a considerable resemblance to that of *Bambusa vulgaris*.

Species dubia, folia tantum.

4. G. APUS, Kurz, MS. in herb. (nomen). *Folia* (2 tantum adsunt) 14 poll. longa, $2\frac{1}{2}$–$2\frac{3}{4}$ poll. lata, basi inæquilatera, attenuata in petiolum supra *scabrum*, subtus *hirsutum*, basi incrassatum, supra glabra, sed medio et ad nervos margini alteri adjacentes scaberrima, subtus scabrula et pilis brevibus hirsuta, margine serrato scaberrima, nervis secundariis tota lamina 26–28, elevatis, conspicuis, venulis transversis inconspicuis. *Vaginæ* sulcatæ, striatæ, margine ciliatæ, superne glabræ, inferne striis pilis albidis adpressis hirsutæ, fovea apice callosa, hirsuta, margine *fimbriata*, ligula truncata, dorso *hispida*, margine tenuissime *ciliata*.—A an *B. apus*? Rœm. et Sch. *l. c.* 1350, et ante, p. 112.

Hab. in Java, hort. Bogor. ("Talie" incolis), *Kurz*. v. s.

These leaves are different from some marked "Apus" in hb. Horsfield, as already mentioned at p. 113. In many respects they correspond perfectly with Schultes's description of *B. apus*, differing principally in having hirsute petioles. Hasskarl, in Cat. Hort. Bog. 295, says that "Apus" belongs to the genus *Dendrocalamus*.

XIII. OXYTENANTHERA.

Munro, nov. gen. *Bambusæ*, sect. *Scirpobambos*, Rich. Fl. Abyss. ii. 439.

Spicula subcylindrica, sæpe elongata et curvata, plerumque pauciflora, flosculis 1–3 tantum, bipaleaceis,

plerumque nonnisi uno, terminali vel penultimo, fertili, rhachilla obsoleta, paleis imbricatissimis, nunc sursum deorsumque, nunc deorsum tantum imperfecta (flosculo terminali tabescente nullo). *Palea* inferior multinervia, acuminata vel spinoso-mucronata, margine nunc pilis sat longis fimbriata, nunc glabra; superior, flosculi fertilis supremi, dorso *convexa*, carinis *obsoletis*. *Squamulæ* nullæ. *Stamina* 6, basi *monadelpha*, antheris mucrone vel seta, sæpe longissima, vel (in *O. Stocksii*) pilis paucis hyalinis apiculatis. *Stylus* gracilis, longus vel longissimus, basi vix incrassatus, apice in stigmata 2–3 interdum longa et plicata divisus. *Caryopsis* angusta, lineari-oblonga, sulco longitudinali notata.

Gramina arborescentia vel scandentia, in Africa tropica, India orientali, Zeylania, Java et insulis adjacentibus crescentia. Folia varia. Inflorescentia vel capitulum, vel panicula decomposita, spiculis in verticillis densis, per ramos dissitis, aggregatis.

The monadelphous stamens often with extremely long points, the absence of squamulæ, the convex, not keeled, upper palea of the fertile flower, and narrow linear oblong fruit are characters which separate this genus from all others.

Conspectus Specierum.

Sect. I. "Scirpobambos." Spiculæ cylindrico-conicæ, 12–20 lin. longæ, in *capitulis*, sæpe terminalibus, dense aggregatæ . . . . . 1. *O. Abyssinica.*

Sect. II. Spiculæ in *verticillis*, secus ramos *dissitis*, aggregatæ.

Spicula *cylindrica*, 9–14 lin. longa, flosculo *terminali* tabescente, *conspicuo, exserto*. Palea inferior acuminata, margine pilis *nigris* vel *violaceis* ciliata . . . . . 2. *O. nigro-ciliata.*

Spicula *cylindrica, angusta*, sub 9 lin. longa, sæpe *curvata*, flosculo *terminali* tabescente *nullo*. Palea inferior margine *pilis albis* fimbriata 3. *O. albo-ciliata.*

Spicula *subcompressa, brevis*, 4–7 lin. longa, sæpius 3-flora, raro 6-flora, flosculis 1–3 bipaleaceis. Palea inferior *spinoso-acuta*, margine *brevissime* fimbriata vel omnino *glabra*. Antheræ *longe* mucronatæ . . 4. *O. Thwaitesii.*

Spicula *teres, brevis*, 6 lin. longa, 4–5-flora, flosculis 2 bipaleaceis, terminali vel ad *pedicellum brevissimum* redacto, vel omnino *obsoleto*. Palea inferior sæpe spinoso-acuminatissima, *nervoso-striata*, margine *glabra*. Antheræ vel mucrone *brevissimo* vel *pilis* 1–2 *hyalinis* apiculatæ . . . . . 5. *O. Stocksii.*

1. O. ABYSSINICA, Munro. Culmo arboreo, spiculis oblongo-conicis, numerosissimis, in capitulis, terminalibus vel spicatis, conglomerato-aggregatis, monoicis, flosculis 1–2 bipaleaceis, palea inferiore dorso plus minus hirsuta, foliis lanceolatis, vaginis ore fimbriatis.—*Bambusa abyssinica*, Rich. Tent. Fl. Abyss. ii. 439; Steud. *l. c.* 330; Walp. Ann. vi. 781. *B. Schimperiana*, Steud. in litt. ad. no. 501 un. itin.

Hab. in Africa tropica, Abyssinia in ripas fluv. Tacazze ("Arkai" et "Chommel" incolis), *Quartin Dillon*, no. 501! *Schimper* (folia tantum); Gallabat, Matamma, no. 2511! *Schweinfurth*; Angola, Pungo Andongo, 2400–3800 ped. s. m., no. 1134! *Welwitsch*; Accra! *Vogel* (folia); Nuffe, *Barter*, 805 (folia). v. s.

Culmus 25–50-pedalis, lignosus, basi $1\frac{1}{2}$–3 poll. diametro, inermis, *glauco-prinosus*, ramis verticillatis, spathis 10 poll. longis, intus glabris, extus hirsutis, margine superne fimbriatis, apiculo lineari-lanceolato, 2 poll. longo, utrinque hirsuto. *Folia* linearia- vel oblongo-lanceolata, plerumque 6–7 poll. longa, 6–12 lin. lata (interdum, in eodem ramo, superiora (more insolito) minora, 6 poll. longa, 6–8

lin. lata, venulis transversis inconspicuis, inferiora 10 poll. longa, $1\frac{3}{4}$ poll. lata, venulis transversis conspicuis), basi subcordata, vel in petiolum hirsutiusculum attenuata, margine serrulato-scaberrima, supra glabra, sed uno latere tactu scabra, subtus pilis brevibus, sæpe vix conspicuis pubescentia, vel glabra, nervis secundariis utrinque 5–10, plus minus conspicuis. *Vaginæ* interdum glabræ, interdum hirsutæ, margine ciliatæ, ore fimbriatæ, ligula brevi, truncata. *Inflorescentia* nunc capitulum densiflorum, in ramis terminale, nunc "capitulis lateralibus superpositis, terminali majore, et quasi spicam vastam, interrupte verticillatam efformantibus." *Spiculæ*, raro fertiles, in capitulis numerosissimæ, acutissimæ, 12–20 lin. longæ, paleis imbricatissimis, flosculis inferioribus 1 paleaceis, glumis similibus, gradatim increscentibus, mucronatis, hirsutis, flosculis (1–2, vel raro 3) superioribus bipaleaceis, vel masculis, vel femineis, vel hermaphroditis. *Palea* inferior (fertilis) 9 lin. longa, acutissima, subspinescens, perfecte convoluta; superior vix brevior, in flosculis bipaleaceis inferioribus 1–2 bicarinata, superne fimbriata, apice hirsuta, bimucronata, in flosculo supremo bipaleaceo, dorso convexa, 10–12-nervia, caryopsin arcte involvens. *Stamina* 6 monadelpha, *antheris* apice mucrone longo hirsuto subulatis. *Stylus* longus, hirtus, basi tandem articulatus, apice in stigmata 3, longa, sæpe plicata, hirtella divisus. *Caryopsis angustissima*, lineari-oblonga, 6 lin. longa, uno latere sulco *fusco* longitudinali notata.

This fine distinct-looking Bamboo seems to have a wide range in Africa, extending into both tropics. Barter says that it was the only arboreal grass he had seen (in Baikie's Niger Expedition), and that the stems were used to pole canoes, and the smaller ones as shafts for spears. This species has a very different appearance from the remainder of the genus; but the structure of the spiculæ in all the species is very similar.

2. O. NIGRO-CILIATA, Munro. Culmo excelso, internodiis floriferis sæpe 9 lin. diametro, glabris, ramis floriferis ad nodos fasciculatis, 3-pedalibus et ultra, spiculis 9–14 lin. longis, angustis, sæpe curvatis, flosculo terminali tabescente conspicuo, exserto, palea inferiore acuminata, apice nervosa, margine pilis sat longis, *nigris* vel *violaceis* fimbriata, foliis basi inæqualibus, subtus pubescentibus vel demum glabris.—*Bambusa nigro-ciliata*, Büse in Pl. Jungh. i. 389; Miq. *l. c.* 416; Walp. Ann. vi. 1045. *B. bitung*, Hassk. Pl. Jav. rar. 42, sed vix Schult. *B. gracilis*, Wall. MS. in Cat. 5033!

Hab. in Ind. or. Tenasserim, *Helfer*, 285! 314!; Martaban, Meaoung! Kogun! in saxis prope mare inter Chappadong et Amherst, *Wallich*, 5033!; Moulmein, *Falconer*, 18! (fol.) 20! (flores), *Lobb*!; Chittagong, *Jones*!; Madras, Canara, Mercara, *Hohenacker*, 527!; ins. Andaman! Sumatra! *Kurz*; Java, *Zollinger*! *Junghuhn*, ("Lengha" incolis) *Horsfield*! v. s.

Culmus 30–40-pedalis (*Helfer*), pulchre striatus (*Wallich*), internodia florifera tantum visa. *Folia* 7–10 vel etiam 12–15 poll. longa, $1\frac{1}{4}$–2 poll. lata, lanceolata, basi rotundata, inæquilatera, breviter petiolata, apice rostrato-acuminata, supra glabra, sed uno latere scabra, subtus pallidiora, pubescentia, vel demum glabra, nervis secundariis, utrinque 8–10–12, mediocriter conspicuis. *Vaginæ*, infra petiolum, abrupte truncatæ, margine fimbriatæ vel glabræ, dorso superne plerumque glabræ, interdum pilis *albis* vel *nigris* adpressis hirsutæ, ligula subelongata vel brevi. *Panicula* maxima, decomposita, internodiis inferioribus glabris, fistulosis, ramis compositis, longis, ramulis gracilibus, interdum 2-pedalibus, ultimis verticillato-spicatis, apice interdum foliatis, spiculis in verticillis $\frac{1}{2}$–$1\frac{1}{2}$–$2\frac{1}{2}$ poll. distantibus, vel paucis vel numerosis, ramulorum internodiis inferioribus glabris, superioribus vel glabris vel, supremis præcipue, hirsutis. *Spicula* cylindrica, angusta, 5–6–7-flora, flosculis 2–3 inferioribus 1-paleaceis, tunc 1–2–3 bipaleaceis, terminali 1-paleaceo, conspicuo, exserto. *Palea* inferior (fertilis) sæpe dorso pubescens (interdum pili nigri sparsi adsunt), basi membranacea, apice

acuminata, vel raro subobtusa, margine pilis *violaceis* vel *nigris* ciliata; superior subæquilonga, carinis longe fimbriatis, apice vel obtusa vel bimucronata, in flosculo supremo dorso convexa. *Stamina* 6, antheris longe exsertis, flexuosis, mucrone *longo, hirsuto* subulatis. *Stylus* longus, apice 3-fidus. *Ovarium* lineari-oblongum, apice hirsutum.

3. O. ALBO-CILIATA, Munro. Culmo diffuso, scandente, internodiis floriferis plerumque apice scabris, spiculis sub 9 lin. longis, *anguste cylindricis*, curvatis, flosculo *terminali* tabescente *nullo*, glumis paleisque inferioribus pilis *albis* longis ciliatis, foliis dubiis.

Hab. in Ind. or. Pegu ("Wapyoogele" incolis), no. 19! *Brandis*; Moulmein, no. 27! Falconer. v. s.

"*Culmus* subscandens, ramis solitariis, circumferentia maxima 4½ poll., internodiis bipedalibus, annulis obliquis, spathis hirsutis, ⅓ internodii æquantibus, foliis deciduis."—*Brandis*. *Folia* dubia. *Panicula* (an culmo terminalis?) composita (pars superior 9-pedalis in hb. Falconer adest), internodiis sæpe 8 poll. longis, inferioribus apice scabris, superioribus glabris et nitidis, ramis inferioribus ad nodos plurimis, superioribus solitariis binisve, simpliciter verticillato-spicatis, interdum 2 pedes longis, internodiis glabris, verticillis densifloris, subæquidistantibus. *Spicula* pallida, deorsum imperfecta, 3–4-flora, flosculis 1–2 inferioribus 1-paleaceis, sterilibus, tertio masculo, *terminali hermaphrodito*. *Palea* inferior acuta, apice immerso-nervosa, margine pilis *albis patulis* fimbriata; superior subobtusa, margine fimbriata. Reliqua ut in *O. nigro-ciliata*.

In addition to the colour of the fringe on the margin of the lower palea, the spicule of this species is distinguished from that of the preceding by the absence of a terminal imperfect flower. In habit it appears to be a much more slender plant, with a much less compound panicle. There are, unfortunately, no leaves actually attached to any of the flowering specimens; so that I have been unable to describe the foliage with any certainty.

4. O. THWAITESII, Munro. Culmo 10–12-pedali, ramulis ad nodos numerosis, inferioribus floriferis basi foliiferis, sæpe 2–3 ped. et ultra longis, spiculis brevibus, 4–6 lin. longis, nunc 5–6-floris, sed sæpius 3-floris, flosculis 1–3 bipaleaceis, palea inferiore margine brevissime fimbriata, vel, in var β, glabra, apice spinoso-acuta, anteris longe mucronatis, foliis lanceolatis, ligula vel brevi vel elongata.—*Dendrocalamus monadelphus*, Thw. in Enum. 376. *Bambusa stricta*, Roxb. Cor. Pl. t. 80! quoad tabulam sed non quoad descriptionem, quæ ad *Dendrocalamum strictum* verum pertinet: "*D. strictus*, var. spiculis glabratis," Nees, MS. in hb. Wight!

Var. β. Spiculis 5–6-floris, palea inferiore margine *glabra*, foliis *pedalibus*, 1¼ poll. latis, ligula elongata.

Hab. in Ceylon, prov. centr. alt. 4000–5000 ped. s. m., no. 3359! *Thwaites*; Ind. or. in montibus Nilghiri, mont. Shevagherry, no. 176!=3430! *Wight*. Var. β, Ceylon! *Thwaites*. v. s.

Culmus inermis, viridis, teres, fistulosus, striatus, circiter 1 poll. in diam., ramosus. *Folia* lanceolata, acuminata, basi subcordata, petiolata, parum obliqua, margine uno vel utroque serrata, supra glabra, subtus primum pilis sparsis vix hirsuta, demum glabra, plerumque 2–5 poll. longa, 6–9 lin. lata, nervis secundariis utrinque 6, venulis transversis obsoletis (in var. β folia 12 poll. longa, 1½ poll. lata, nervis secundariis utrinque 10–12, venulis transversis *conspicuis*). "*Vaginæ* fugaci-albido-pilosæ, apice longe caduco-ciliatæ," ligula nunc brevi, nunc elongata, apice membranacea, obtusa. *Inflorescentia* (an culmo foliifero terminalis?) panicula decomposita, ramis inferioribus sæpe longissimis, valde ina-

qualibus, floriferis, basi foliiferis, superioribus omnino floriferis, brevioribus, internodiis inferioribus glabris, interdum 8 poll. longis, viridibus, striatis, verticillis sæpissime densifloris, subglobosis, raro ad nodos dense aggregatis, plerumque secus ramulos regulariter spicatis. *Spicula* acuta, lineari-oblonga, plerumque 3-flora, rarius 5–6-flora, flosculis 2 inferioribus unipaleaceis, sequentibus 1–3 bipaleaceis, terminali tabescente nunc conspicuo, nunc obsoleto. *Palea* inferior dorso glabra, 15–20-nervosa, margine vel *brevissime fimbriata*, vel *glabra*, subulato-acuta; superior vix brevior, in flosculo bipaleaceo supremo dorso *convexa*, 9-nervis, margine ciliata, apice subpilosa, in reliquis obtuse-bicarinata. "Antheræ angustæ, subulato-apiculatæ, apiculo *piloso*." *Stylus* apice 3-fidus. *Caryopsis* (matura) 3 lin. longa, lineari-oblonga, apice acuta et glabra.

Roxburgh's drawing in the 'Plants of the Coast of Coromandel' was undoubtedly taken from a plant of this species; but the description, with which the drawing does not agree, was probably written at a later date, and is very nearly in the same words as those used in the 'Flora Indica,' ii. 193, for the real *Dendrocalamus strictus*. I have been unwilling to change Thwaites's specific name for this plant; but as the whole genus have monadelphous stamens, it was no longer a distinctive one, and I have therefore named it after the excellent botanist who first described the plant correctly.

5. O. Stocksii, Munro. Culmo gracili, internodiis 4–7 poll. longis, glaberrimis, ramis ad nodos paucis, spiculis sub 6 lin. longis, teretibus, acutissimis, glabris, plerumque 4–5-floris, flosculis 2 bipaleaceis, terminali vel lineari brevissimo, vel omnino obsoleto, palea inferiore *membranacea*, margine *glabra*, in flosculis superioribus interdum spinoso-acutissima, antheris vel *brevissime* mucronatis, vel *pilis hyalinis* 1–2 brevibus apiculatis, foliis angustis, subtus *hirsutis*.

Hab. in Ind. or. Concan, *Stocks*. v. s.

Folia lineari-lanceolata, apice mucronato-acuta, basi cordato-rotundata, vel attenuata in petiolum complanatum, basi incrassatum, brevem, subtus hirsutum, 3–4 poll. longa, 4–6 lin. lata, supra hirsuta vel glabra, subtus hirsuta, nervis secundariis utrinque 4–5, inconspicuis. *Vaginæ* striatæ, plerumque glabræ vel primum pubescentes, ore fimbriatæ. *Inflorescentia*, ut videtur, ei præcedentis similis (ramuli floriferi 3 tantum adsunt), verticillis interdum $1\frac{1}{4}$ poll. diametro, densissimis, fere echinatis, in ramulis approximatis. *Spicula* 4–5-flora, glabra, flosculis 2 inferioribus unipaleaceis brevibus, dorso nitidis, apice mucronatis, 2 sequentibus bipaleaceis, terminali *brevissimo* vel obsoleto. *Palea* inferior (fertilis) membranacea, per totam longitudinem *striato-nervosa*, apice mucrone sæpe longo spinoso subulata; superne, in flosculo tertio, bicarinata, obtusa, carinis fimbriata, in quarto convexa obtusa. *Stamina* 6, antheris vel *brevissime* mucronatis, vel *fere obtusis*, vel pilis 1–2 hyalinis apiculatis. *Stylus* apice 2–3-fidus. *Ovarium* (immaturum) apice hirsutum.

The leaves of this species are remarkably like those of *Dendrocalamus strictus*. The short points to the anthers and striated membranous lower palea are the chief points of distinction between this and the preceding species.

Sectio III. Bacciferæ (conf. supra, p. 12).

Conspectus Generum.

Subsectio I. Schizostachyoidea. Rhachis propria, nisi in Cephalostachyo, bis terve fasciculatim divisa; tandem spicula fertilis, plerumque cylindrica, flosculis (1 vel raro 2) hermaphroditis, supra glumas articulata. Squamulæ 3 vel raro 2 aut nullæ.

Spiculæ *spicatæ*, oblongæ vel cylindricæ, flosculis 1–2 *bipaleaceis*, hermaphroditis. Squamulæ 3 vel raro 2. Fructus (in specie unica tantum notus) *magnus, carnosus*, pomiformis, rostratus . . . . . 14. *Melocanna*.

Spicula cylindrica, paleis imbricatissimis, involventibus, flosculo 1 hermaphrodito, plerumque *unipaleaceo*, rarissime (in specie unica) bipaleaceo. *Squamulæ nullæ*. Fructus (tantum in specie unica notus) oblongus, rugosus, rostro brevi subito cuspidatus . . . . . 15. *Schizostachyum*.

Spiculæ cylindricæ, in *capitulis* densis, plerumque *terminalibus* congestæ, flosculo 1 hermaphrodito, bipaleaceo. Squamulæ 3. Fructus longe attenuato-rostratus . . . . . 16. *Cephalostachyum*.

Spiculæ oblongæ, *membranaceæ*, spicatæ, flosculis 1–2 hermaphroditis, bipaleaceis. Squamulæ 3 vel 5. Fructus *globosus* rostro longo subito rostratus. Tab. IV. . . . . 17. *Pseudostachyum*.

Subsectio II. Bambusoidea. Spicula structura *Bambusæ* similis, flosculis 1–2 vel plurimis fertilibus. Squamulæ 3, vel *plurimæ*, vel *nullæ*. Fructus *bacciformis*, plerumque rostratus.

Spicula *elongata*, cylindrica, *pluriflora*, flosculis 3–5 fertilibus. Squamulæ 3. Fructus rostratus. Tab. III. . . . . 18. *Teinostachyum*.

Spicula subcylindrica (fructifera major, conoideo-cylindrica), flosculo 1 bipaleaceo, hermaphrodito. Squamulæ *plurimæ* vel raro (in specie unica) 3. Stamina *plurima* vel 6. Fructus longe rostratus . . . . . 19. *Beesha*.

Spicula oblonga vel ovata, flosculis 2 vel *plurimæ* perfectis. Squamulæ veræ *nullæ*. Fructus oblongus, plerumque rostratus. Tab. VI. . . . . 20. *Dendrocalamus*.

Spicula minima, ovata, flosculo *terminali solo* bipaleaceo. Squamulæ *nullæ*. Fructus oblongus, brevissime rostratus. Tab. V. . . . . 21. *Dinochloa*.

XIV. Melocanna.

Trinius in Sprengel, Neue Entd. ii. 43 (1821). *Beesha*, Kunth, 'Notice sur le genre Bambusa' (1822); Endl. no. 910, sed non Rheede (1685). *Bambusæ* sp., Roxburgh. *Schizostachyi* sp., Steud. et Miquel.

Spicula utrinque imperfecta, pauciflora, flosculo plerumque 1, raro 2 hermaphroditis, terminali tabescente, conspicuo, nunc subovata, nunc cylindrica, fertilis basi, supra glumas, articulata. *Glumæ* numero indefinitæ, forsan omnes gemmiparæ. *Palea* inferior flosculi fertilis paucinervia, in speciebus 2 membranacea, in reliquis coriacea, plerumque scabra et sæpe involutissima; superior sæpe longior, in speciebus "*bambusoides*" et "*Kurzii*" membranacea, in reliquis coriacea, involuta, raro carinata, plerumque dorso convexa. *Squamulæ* 3, vel raro 2, plerumque fimbriatæ, sæpe *persistentes*. *Stamina* plerumque 6, raro 5–7, antheris vel obtusis vel mucronatis. *Stylus longus*, apice trifidus. *Ovarium* longe rostratum, rostro sæpe angulato, glabro vel subhirsuto. *Fructus*, in *M. bambusoide*, maximus, pomiformis, carnosus, acuminatus, edulis, in reliquis ignotus.

Gramina arborea vel fruticosa, in India orientali, et inss. Singapore, Java, et Andaman indigena. Folia plerumque lata, petiolata, venulis transversis nullis vel obsoletis, vaginis ore ciliis longis, interdum deciduis fimbriatis. *Inflorescentia* nunc panicula vasta, supra decomposita, aphylla, spiculis spicatis, imbricatis, bracteis velatis, nunc panicula decomposita, aphylla, spiculis in fasciculis secus ramos elongatos dissitis, nunc panicula fere simplex in ramis basi foliatis terminalis, fasciculis plerumque simplicibus verticillato-spicatis.

I think it is very probable that *Schizostachyum* of Nees, which is principally distinguished by the absence of squamulæ, is merely an incomplete state of this genus; or per-

haps this genus should have been confined to the one typical large-fruited species, and the remainder placed in *Schizostachyum*, with an enlarged character.

Conspectus Specierum.

Sect. I. Typica. Culmus arboreus.

Panicula *ampla*, supradecomposita. Paleæ *membranaceæ*. Squamulæ 2. Fructus *magnus, pomiformis, carnosus* . . . . . 1. *M. bambusoides.*

Sect. II. Dubiæ. Culmus subarboreus vel frutescens. Fructus ignotus.

Panicula decomposita, *aphylla*, ramis valde *elongatis*, sæpe compositis. Spicula plerumque sesquiflora, paleis *coriaceis*. Antheræ obtusæ . . . 2. *M. virgata.*

Panicula subsimplex, basi foliata, fasciculato-spicata, fasciculis 3–4. Spicula 3–4-flora, paleis *coriaceis*. Antheræ obtusæ. Folia *angusta, nervis* secundariis *inconspicuis* . . . . . 3. *M. gracilis.*

Panicula ut in *M. gracili*, fasciculis plurimis. Spicula 3–4-flora, paleis *coriaceis*. Antheræ obtusæ. Folia *lato-lanceolata, nervis* secundariis *conspicuis* . 4. *M. Zollingeri.*

Panicula ut in *M. gracili*. Spicula 3–5-flora, paleis *membranaceis*. Antheræ *longe mucronatæ* . . . . . 5. *M. Kurzii.*

1. M. BAMBUSOIDES, Trin. *l. c.* 43. Culmo arboreo, excelso, apice tantum ramoso, panicula supradecomposita, basi aphylla, spiculis 3–4-floris, paleis membranaceis, squamulis 2, ovario apice rostrato, demum carnescente, in fructum *pomiforme*, interdum 5-pollicare, increscente, foliis ovato-lanceolatis, vaginis ore longe fimbriatis.—Spreng. Syst. ii. 113 (excl. syn. Lour.); Rupr. *l. c.* 155; Steud. *l. c.* 331; Miq. *l. c.* 423. *Bambusa baccifera*, Roxb. Hort. Beng. 25 (1814); Corom. Pl. iii. 38, t. 243 (1819); Fl. Ind. ii. 197. *Beesha Rheedei*, Kunth, *l. c.*; Rev. Gram. i. 141; Enum. 434 (excl. syn. nonnull.), non Rupr. *l. c.* ad not. *Beesha baccifera*, Rœm. et Sch. *l. c.* 1336. *Nastus baccifera*, Rasp. *l. c.* v. 442.

Hab. in Ind. or. Chittagong, spontanea ("Moolli" et "Metunga"), *Hooker*! *Jones*!, ("Bish Bans") *Roxburgh*; Sylhet, *Wallich*! Cachar ("Moolli") *Verner*; Tipperah, *Campbell*; Arracan, *Theobald*; Akyab, *Tickell*; cult. hort. bot. Calc., *Thomson*; Moulmein! *Falconer*; île Bourbon! *Boivin*; Mauritius! *Ayres* (var. ramo florifero basi foliato). v. s.

Culmus 50–70-pedalis, basi peripheria 12–13 poll., erectus, apice tantum ramosus, fistulosus, parietibus tenuibus, "tabasheer" fundens. *Folia* ovato-lanceolata, basi attenuata, inæquilatera, petiolata, petiolis flavescentibus, apice setaceo-acuminata, 6–12 poll. longa, 1–2–4 poll. lata, utrinque glabra, sed supra ad unum latus scabra, subtus pallidiora, nervis secundariis utrinque 8–14, subconspicuis. *Vaginæ* glabræ vel villosæ (teste Roxb.), ore fimbriatæ, ligula inconspicua. *Panicula* supradecomposita, ramis ramulisque iterum iterumque divisis, ultimis spiculas spicatas, inferiores steriles, supremas tantum fertiles, bracteis involutas gerentibus. *Spicula* fertilis supra glumas articulata, 3–4-flora, flosculis 1–2 inferioribus neutris vel masculis, penultimo hermaphrodito, terminali tabescente, interdum ad pedicellum redacto, interdum paleis duabus prædito. *Palea* inferior (flosculi hermaphroditi) membranacea, 9-nervia, apice acuminata; superior tenuimembranacea, subæquilonga, dorso vix carinata. *Squamulæ* 2, paleæ inferiori oppositæ, lineari-oblongæ, apice obtusæ, margine fimbriatæ, 3–5-nerviæ, *persistentes*. *Stamina* 5–7, longa, basi libera, antheris, demum *tortis*, subobtusis. *Stylus* longus, attenuatus, apice 2–3–4-fidus, stigmatibus brevibus, pilosis. *Ovarium* longe attenuatum, cito crescit et carnescit. *Fructus* pomiformis, 3–5-pollicaris, *carnosus*, apice curvatus et acuminatus.

The very curious fruit of this species is remarkably well figured by Roxburgh in the 'Plants of the Coast of Coromandel.' The plant appears to have fruited abundantly in Arracan in 1864 and 1865; and Mr. Theobald states that "the true seed inside the fleshy pericarp, about the size and shape of a small betel-nut, is very pleasant eating, and not at all austere, though without much flavour. The natives declare the whole fruit is edible after baking." Some further particulars about the flowering of this plant will be found at p. 3.

2. M. VIRGATA, Munro. Culmo subarboreo?, internodiis floriferis interdum 12–15 poll. longis, glabris, vel apice scabrulis; panicula longissima, *ampla*, *nutante* aphylla, ramis fasciculatis, paucis vel plurimis, virgatis, simplicibus vel compositis; spiculis in fasciculis, interdum proliferis, nunquam densifloris, per ramos dissitis; spicula cylindrica, acuta, pauciflora; flosculo uno fertili; paleis *coriaceis subhirsutis*.—*Bambusa*, sp., Griffith, Journ. p. 89.

Hab. in Ind. or. Burmah, Keouksik ad fluv. Mogong, *Griffith*. v. s.

Panicula aphylla tantum adest, decomposita, rhachi glabra, ramis inæqualibus, sæpe pedalibus, internodiis teretibus vel uno latere planis, fasciculis, plerumque sessilibus, interdum pedunculatis et compositis, interdum longe distantibus, basi bracteatis. *Spicula* fertilis acuta, angusta, sub 6 lin. longa, plerumque *sesquiflora*, flore inferiore bipaleaceo, fertili, ad basin, flore tabescente, pedicellato, fertili breviore aucto. Flos terminalis interdum major et bipaleaceus, sed semper sterilis. *Palea* inferior dorso sparse hirsuta, coriacea; superior sulcata, apice bimucronata, inferiore longior, carinis non ciliatis. *Squamulæ* 3, lanceolatæ, inconspicue nervatæ, margine tenuiter fimbriatæ, interdum basi coalitæ, subinæquales. *Stylus* longissimus, stigmatibus 2–3, brevibus, plumosis. *Ovarium* (immaturum) basi stipitatum, longe rostratum. Folia desunt.

The structure of the spicula is similar to that of the three following species; but the inflorescence is much more compound than in any of them.

3. M. GRACILIS, Kurz, MS. in hb. Culmo suffruticoso, 10-pedali, ramis numerosis, brevibus, fasciculatis, ramo florifero, basi foliato, fasciculos spicularum 3–4, simpliciter spicatos gerente; spicula sub 3–4-flora; foliis angustis, lineari-lanceolatis, nervis secundariis ægre a tertiariis discernendis; vaginis ore ciliis cito deciduis fimbriatis.—Cat. Bot. Gar. Calc. 79. *Bambusa*, Wall. Cat. 5032.

Hab. in Singapore, 5032! *Wallich*; Java, hort. Bogor. et Calc. Bot. Gard., *Kurz*. v. s.

Culmus gracilis, internodiis glaberrimis, fistulosus, ramulis foliiferis floriferisque ad eundem nodum semiverticillatis. *Folia* angusta, 5–6 poll. longa, 6–8 lin. lata, apice setaceo-acuminata, basi rotundata, petiolata, petiolo fusco, margine aspera, utrinque glabra, subtus pallidiora et punctulis minutissimis asperiuscula, raro pilis parvis basin versus, ad costam sparsis, nervis secundariis utrinque 3–4, ægre a tertiariis discernendis, venulis transversis fere obsoletis. *Vaginæ* margine primum ciliatæ, glabræ, sulcatæ, abrupte truncatæ, ore ciliis paucis, cito caducis fimbriatæ. *Panicula* spicata, brevissima, fasciculis parvis, paucis, (in spec. visis) 3–4. *Spicula* vix 4 lin. longa, nunc 4-flora, floseulis 2 inferioribus et terminali sterilibus, nunc *sesquiflora*, flore terminali tabescente. *Palea* inferior nervosa, coriacea, acuta, superiore bicarinata sulcata brevior. *Stamina* 6, filamentis plerumque brevibus, antheris *fusco obtuse* apiculatis. *Stylus* longissimus, apice breviter 2–3-fidus. *Squamulæ* 3, angustæ, oblongæ, fimbriatæ, 3–5-nervosæ, subinæquales. *Ovarium* (immaturum) longe rostratum.

This is principally distinguished by its narrow leaves, with very inconspicuous secondary nerves, from *M. Zollingeri.*

4. M. Zollingeri, Kurz, MS. in hb. Culmo suffruticoso, internodiis glaberrimis, vel apice scabris, ramis ad nodos fasciculatis, patulis, nunc foliiferis tantum, nunc apice floriferis, fasciculis spicularum spicatis, approximatis, spiculis paucifloris, plerumque 4–6 lin. longis, foliis 6–12 poll. longis, $\frac{3}{4}$–$1\frac{3}{4}$ poll. latis, sæpe plicatis, nervis secundariis utrinque 6–10–12, *conspicuis*, vaginis glabris, ore fimbriatis.—*Schizostachyum Zollingeri*, Steud. *l. c.* 332, forsan *S. iraten*, Steud. *l. c.*, var. ramis striatis puberulis. *S. Blumei*, Miq. *l. c.* 424 sed non Nees.

Var. β. *brachyclada*, Kurz, *spiculis* 4–5-floris, flosculis 2 perfectis, spicæ densæ verticillis multifloris, foliis subtus *hirsutis.*

Var. γ. *longispiculata*, Kurz, spiculis $1\frac{1}{2}$ poll. longis.

Hab. in Java ("Tring Embon" incolis), *Horsfield*; Buitenzorg ("Bamboe Koeda"), hort. Bogor. ("B. gohlah-ab"), *Kurz*, 717! 3529 *Zollinger*; var. β, Buitenzorg ("Boeloe Konning"), var. γ, hort. Bogor, *Kurz*. v. s.

Culmus inermis, teres, nodis vel glabris vel raro hirsutis, ramis raro tantum floriferis, plerumque sursum foliiferis et spica terminatis. *Folia* lanceolata, basi attenuata in petiolum subbrevem, apice acuminatissima, margine scabra, glaucescentia, utrinque glabra, vel interdum subtus hirsuta, non raro tactu asperiuscula. *Vaginæ* plerumque glabræ, interdum tactu scabræ, margine ciliatæ, raro lateribus biauriculatæ, fovea emarginata, glabra vel fimbriata, ore ciliis sat longis sæpe deciduis pulchre fimbriatæ. "*Panicula* subspicata, terminalis, subcontinuo vel brevi interrupte fasciculis spicarum, nunc pauci- nunc plurispiculatarum obsessa" (*Steud.*), fasciculis inferioribus interdum proliferis, 2–3 poll. longis. *Spicula* fertilis plerumque brevis, 4–8 lin. longa, interdum (in var. γ) $1\frac{1}{2}$ poll. longa, plerumque 4-flora, flosculis inferioribus 2 sterilibus, tertio bipaleaceo, hermaphrodito, rudimento flosculi quarti plus minus conspicuo; (in var. β) spicula 5-flora, flosculis 2 intermediis bipaleaceis. *Palea* inferior (fertilis) nervosa, scabra, *coriacea*, superiore bicarinata brevior, apicem versus tenuiter ciliata. *Squamulæ* 3, oblongæ, fimbriatæ. *Stamina* 6, rarius 3 (teste Steud.), antheris obtusis. *Stylus* longus, apice 3-fidus. *Ovarium* (immaturum) longe rostratum, rostro tenui puberulo.

5. M.? Kurzii, Munro. Culmo suffruticoso? ramis floriferis basi foliiferis, panicula simplici, verticillato-spicata, verticillis paucifloris, bractea elongata basi stipatis, spicula 3–5-flora, flosculis 2 intermediis bipaleaceis, hermaphroditis, paleis *submembranaceis*, squamulis 2–3, antheris *longe mucronatis*, foliis lanceolatis, vaginis dorso hirsutis, apice auriculato-fimbriatis.—*Bambusa schizostachyoides*, Kurz in hb.

Hab. in ins. Andaman, *Kurz*. v. s.

Culmus, ut videtur, suffruticosus, internodiis superioribus brevibus, striatis, fistulosis, ramis ad nodos 1–4, basi foliiferis, apice floriferis. *Folia* lineari- vel oblongo-lanceolata, 5–8 poll. longa, 9–12 lin. lata basi rotundata vel attenuata in petiolum brevem, supra hirsutiusculum, margine asperrima, utrinque glabra, sed supra ad unum latus aspera, nervis secundariis utrinque 6–8, inconspicuis. *Vaginæ* primum pilis fuscis hirsutæ, biauriculatæ, *auriculis fimbriatis*. *Panicula* spicata, fasciculis paucispiculatis, subæquidistantibus. *Spicula* teres, 4–6 lin. longa, dimorpha, nunc 3-flora, angustior, flosculo infimo sterili, 2 sequentibus bipaleaceis, terminali obsoleto, nunc 5-flora, 1–2 terminalibus incompletis, sterilibus, *rhachillæ articulis* 1–2 visibilibus, brevibus, *obovatis*. *Palea* inferior (fertilis) nervosa, dorso glabra, margine breviter fimbriata; superior brevior vel longior, *eximie membranacea*, *bicarinata*, carinis ciliatis. *Squamulæ* nunc 3 inæquales, nunc 1–2 obsoletæ, lanceolatæ, angustæ

fimbriatæ. *Stamina* 6, antheris *mucrone hirsuto* apiculatis. *Stylus* longus, apice trifidus. *Ovarium* (immaturum) *stipitatum*, apice longissime attenuato-rostratum, rostro subhirsuto.

The inflorescence and foliage of this species is very similar to that of the preceding species; but the spicula is different in appearance, although, I think, really similar in structure.

Species minus nota, valde dubia.

6. M. HUMILIS, Roepert in Trin. Clav. Agr. 105. "Culmo humili, 15–18-pedali, crassitie pollicis—brachii, ad nodos sæpe ramulos foliosos emittente; foliis anguste lanceolatis, 6–12 poll. longis, 1½ poll. latis, viridibus, subtus *lanuginosis*; fructibus *rugosis*, imbricatis, medulla alba sicca repletis" (sec. desc. Rumph.).—Spreng. Syst. ii. 113; Rupr. *l. c.* 154; Steud. *l. c.* 331; Miq. *l. c.* 423. *Beesha? humilis*, Kunth, Enum. 434. *B. Fax*, Rœm. et Sch. *l. c.* 1336 (excl. syn. nonnull.). *Arundarbor cratium*, Rumph, Amb. iv. 5. An *Arundo fax*, Lour. *l. c.* 74?

Hab. ab Amboina ad Javam, *Rumphius*.

MELOCANNA EXCELSA, Roep. = *Bambusa maxima*, Poir.
M. RHEEDII, Steud. = *Beesha Rheedii*, Rupr.

XV. SCHIZOSTACHYUM.

Nees ab Es. in Agrost. Bras. 535 (1829), Rupr. *l. c.* t. xvii f. 44 (*analysis*).

Spicula utrinque vel deorsum tantum imperfecta, cylindrica, angusta, plerumque elongata, fertilis supra glumas articulata, spiculis sterilibus plurimis stipata, plerumque 3–4-flora, flosculo *uno* tantum fertili. *Glumæ* plurimæ, fere omnes gemmiparæ, a spicula fertili remotæ. *Paleæ* omnes *imbricatissimæ*, 2–3 inferiores vacuæ, steriles, suprema vel penultima sola fertilis, genitalia arcte involvens. Palea superior (nisi in *S. parvifolio*) deest vel ad rudimentum minutum vel lineare redacta. *Squamulæ nullæ*. *Stamina* 6, antheris obtusis. *Stylus* longus, ovarii rostro inclusus, stigmatibus 3 brevissimis. *Caryopsis* matura (in *S. acutifloro* tantum visa) oblonga, *rugosa*, *obtusa*, rostro brevi subito cuspidata.

Gramina arborea vel suffruticosa, vel subscandentia, in Madagascar, China, Java, Tahiti et aliis insulis Oceani Pacifici crescentia. Folia nunc lata nunc angusta. Inflorescentia variabilis, panicula nunc ampla, decomposita (in *S. acutifloro*), nunc composita, nunc fere simplex, fasciculis interrupte spicatis.

This genus is very closely allied to *Melocanna*; and I have now retained in it only those species in which the squamulæ are deficient and the upper palea generally obsolete or altogether wanting. In one species, however, as stated above, the upper palea is present.

Conspectus Specierum.

Panicula subsimplex, fasciculis paucispiculatis, interrupte spicatis. Spicula *elongata, cylindrica*, flosculo FERTILI *bipaleaceo*. Vaginæ auriculato-fimbriatæ .	1. *S. parvifolium*.
Panicula, ut in præcedente, fasciculis interdum proliferis. Spicula elongata, cylindrica, flosculo fertili 1-*paleaceo*. Vaginæ ore tenuiter fimbriatæ . . .	2. *S. dumetorum*.
Panicula composita, ramis *inferioribus elongatis*, verticillato-spicatis. Spicula elongata. Palea superior flosculi fertilis ad rudimentum lineare redacta. Folia *lata*	3. *S. Blumei*.
Panicula *decomposita*, verticillato-spicata, ramis floriferis e verticillis erumpentibus. Spiculæ omnes in speciminibus visis *vacuæ*. Folia *lata*	4. *S. glaucifolium*.
Panicula supradecomposita, ramis iterum ramulosis, *ramulis* ultimis *spiculiferis*. Spicula subbrevis, acuta. Folia *lineari-lanceolata*	5. *S. acutiflorum*.

1. S. PARVIFOLIUM, Munro. Culmo suffruticoso, ramis foliiferis sæpe apice floriferis, ad nodos sæpe numerosissimis, panicula angusta, fasciculis approximatis, imbricatis, flosculo fertili *bipaleaceo*, foliis parvis, angustis, subtus *hirsutis*, vaginis miro modo utrinque *auriculatis*, auriculis longe fimbriatis.

Hab. in Madagascar, Nossi-bé, no. 1978! îles Comores, Mayotta, no. 3030! *Boivin in herb. Mus. Paris*, no. 74! *Gerrard.* v. s.

Culmus 8–10-pedalis (*Gerrard*), internodiis inferioribus 9 poll. longis, 3 lin. diam., glabris, apice tenuissimus, filiformis, ramis brevibus. *Folia* lineari-lanceolata, 1–3½ poll. longa, 3–5 lin. lata, basi attenuata, vix petiolata, apice mucronata, supra glabra, vel raro hirsutiuscula, subtus pilis sat longis hirsuta, vel raro glabra, nervis secundariis utrinque 2–3. *Vaginæ* primum hirsutiusculæ, demum glabræ, utroque latere auriculatæ, auriculis linearibus, pedatis, *elongatis*, interdum *apicem versus ramosis*, et ciliis longis subfuscis fimbriatis. *Panicula* subsimplex, fasciculis paucifloris, subspicatis. *Spicula* elongata (nondum evoluta), flosculis omnibus imbricatissimis, 2–3 inferioribus sterilibus, penultimo bipalcaceo, hermaphrodito, terminali tabescente brevissimo, glumis nunc glabris, nunc longe fimbriatis. *Palea* inferior convoluta, 7–9-nervia, acuminata; superior multo brevior, apice *bifida*. Genitalia immatura. *Stamina* 6. *Stylus* apice 3-fidus.

The remarkable auricles of the vaginæ and very small leaves distinguish this from the remainder of the genus. In inflorescence it is very similar to the next species.

2. S. DUMETORUM, Munro in Seem. Bot. Her. 424. Culmo 4–6-pedali, panicula ramis terminali, fasciculato-spicata, fasciculis 1–4 poll. distantibus, inferioribus interdum proliferis, spiculis gracilibus, cylindricis, flosculo uno fertili, 1-paleaceo, foliis lanceolatis, supra scabris, subtus *glabris*.—Benth. Fl. Hongk. 435. *Bambusa dumetorum*, Hance in Walp. Ann. iii. 781; Steud. *l. c.* 331.

Hab. in China, no. 164! *Fortune*; Hongkong, *Seemann*! 255! *Wilford, Hance.* v. s.

Culmus frutescens, 4–6-pedalis, multicaulis, tenuis, inermis, lævis. *Folia* lanceolata, petiolata, apice mucronata, basi rotundata, 3–6 poll. longa, 4–12 lin. lata, nervis secundariis utrinque 4–5. *Vaginæ glabræ*, ore ciliis subrigidis deciduis fimbriatæ. *Panicula*, in ramis fasciculatis 3–6–12 poll. longis, plerumque terminalis, adjecto interdum ad nodum "fasciculo spicularum dense congestarum." *Spiculæ* 3–6, fasciculatæ, attenuatæ, divaricatæ, ½–1 poll. longæ, flosculis 3–4 inferioribus sterilibus, imbricatis, gradatim increscentibus, terminali fertili unipaleaceo, genitalia arcte involvente. *Stamina* 6. *Stylus* longus, rostro ovarii (longo, angulato) inclusus, apice in stigmata 3 brevissima divisus. *Ovarium* (immaturum) longissime rostratum.

3. S. BLUMEI, Nees ab Esen. in Agrost. Bras. 535. Culmo arborescente, panicula composita, ramis elongatis, approximatis, simplicibus, spiculis in glomerulos secus ramos dissitos congestis, cylindricis, acutissimis, palea superiore subobsoleta, foliis *latis*, *plicatis*, sublonge petiolatis.—Rœm. et Sch. *l. c.* 1355; Kunth, Enum. 435; Rupr. *l. c.* 133, t. xvi. (xvii. f. 44), analysis optima; Steud. *l. c.* 332; Miq. *l. c.* 424, excl. syn. plur.

Hab. in Java, *Blume.* Vidi spec. in hb. Wight sine loco indicato.

Culmus arboreus. *Folia* (in spec. visis) floralia, 9–10 poll. longa, 1¼–1¾ poll. lata, lanceolata, basi rotundata, longe petiolata, utrinque scabra, apice rostrato-acuminatissima, margine aspera, nervis secundariis utrinque 9–11, plus minus conspicuis. *Vaginæ* inferne nitidæ, superne sulcato-striatæ, et inter strias sæpe hispido-scabræ, ore ciliis cito caducis fimbriatæ, ligula brevi, truncata, sæpe apice fimbriata. *Panicula* ramulis (basi foliiferis) terminalis, 10–14 poll. longa, ramosa, internodiis

breviter hispidis, ramis 5–2 poll. longis, alternis, solitariis, erectis, capitulis parvis, 3 lin. latis, interrupte verticillatis. *Spicula* cylindrica, acuta, sub 6 lin. longa, flosculo fertili nunc unipaleaceo, nunc bipaleaceo (palea suprema nunquam perfecta, interdum obsoleta), terminali tabescente nunc conspicuo, nunc deficiente. *Palea* inferior 15–17-nervis. *Stamina* 6 obtusa. *Stylus* apice 3-fidus.

The only specimens which I have seen in flower are those contained in Wight's herbarium, without any locality attached; and from these I have made my description. The inflorescence, as described by Schultes, would occasionally appear to be very different from that described, and in some respects rather resembling that of *S. glaucifolium*.

4. S. GLAUCIFOLIUM, Munro. "Culmo humili, 9-pedali," panicula decomposita, internodiis superioribus 4–3–2 poll. longis, striatis, asperiusculis, ramulis floriferis brevibus, ad nodos fasciculatis, e capitulo denso, $1\frac{1}{4}$ poll. diam., ad quemque nodum sessili, erumpentibus, ramis interrupte glomerato-spicatis, spiculis angustis, cylindricis, pallidis, omnibus sterilibus (in spec. viso), foliis latis, basi angustatis, petiolatis. —*Bambusa glaucifolia*, Rupr., *l. c.* 147; Steud. *l. c.* 331. *Bambos arundo*, Solander. Fl. Ins. Ocean. Pacif. 217.

Hab. in insulis Oceani Pacifici, Tahiti, Hawaii! *Wilkes* (florif.), no. 130, *Guillemin*, ("Ovhe" incolis) *Bertero, Moehroch*; Fiji ("Bitu" incolis), 694! *Seemann*; Samoa, Fiji, *Wilkes*; Nukahiva, *Kyber*. v. s.

Culmus ad nodos ramos paucos (1–2) 1–2-pedales emittens, nodis parum tumentibus, glabris. *Folia* ovato- vel lineari-lanceolata, glabra, 8–17 poll. longa, $1\frac{1}{2}$–2 poll. lata, longe acuminata, basi inæquilatera, in petiolum 2–3–5 lin. attenuata, glauca, plicata, margine imo lævia, superne tantum hispidula, basin versus macula flavo-aurantiaca insignata, nervis secundariis utrinque 11–14."—*Ruprecht*. Paniculæ pars suprema $1\frac{1}{2}$-pedalis adest, efoliata, ramis tenuibus, 1–4 poll. longis, capitula 2–4 ferentibus.

I have seen only one flowering specimen of this plant, which was collected at Tahiti in Wilkes's Expedition. Unfortunately, although the spiculæ are numerous, there is not one which contains the least trace of genitalia. Every spicula is sterile; and I therefore think it is very possible that the specimen I have seen may be a proliferous barren sport. The inflorescence agrees to some extent with one of the states of *S. Blumei* described by Schultes.

5. S. ACUTIFLORUM, Munro in hb. T. C. D. Culmo suffruticoso, vel scandente, panicula ampla, decomposita, 4-pedali et forsan ultra, fistulosa, ramis ramulosis, spiculis brevibus, acutis, secus ramulos dense verticillato-spicatis, fructu oblongo, rugoso, foliis lineari-lanceolatis, vaginis utrinque auriculato-fimbriatis.

Hab. in ins. Philippinis, 544! *Cuming*, Luçonia! *Wilkes*. v. s.

Culmus, ut videtur, pluripedalis. *Folia* 6–9 poll. longa, 8–10 lin. lata, basi rotundata, vel vix attenuata in petiolum brevissimum, ima basi incrassatum, apice mucronato-acuta, utrinque tactu scabra, subtus interdum pilosa, margine asperrima, nervis secundariis utrinque sub 6, conspicuis. *Vaginæ* superne, margines versus præcipue, strigoso-hirsutæ, utrinque auriculatæ, auriculis latis, reversis, longe fimbriatis, ligulis brevibus, sæpe longe fimbriatis. *Panicula* (pars $3\frac{1}{2}$-pedalis adest) vel aphylla vel ramo uno alterove basi foliato, internodiis 5–2 poll. longis, inferioribus subglabris, superioribus scaberrimis, ramis tenuibus, solitariis vel fasciculatis, inferioribus ramulosis, ramulis alternis, subpollicaribus, fasciculis brevibus, dense spicatis, ramis superioribus simplicibus, dense spicatis. *Spicula* acuta,

3–4 lin. longa, cylindrica, plerumque sterilis, rarissime fructifera, 3-flora, flosculis 2 inferioribus sterilibus, acutis, terminali unipalcaceo, genitalia arcte amplectente, rudimento terminali nullo. *Squamulæ* nullæ. *Stamina* 6, antheris *breviter mucronatis*. *Stylus* longus, gracilis, in stigmata 3, plumosa, revoluta, sublonga divisus. *Ovarium* (immaturum) angustum, rostratum. *Fructus* maturus ovato-oblongus, niger, sub 5 lin. longus, rugosus, apice depressus, rostri residuo subito apiculatus, paleis *tribus persistentibus* quasi involucratus. Semen, a pericarpio prompte solutum, oblongum, scutello *centrali* hirsuto.

The above-described very remarkable fruit distinguishes this from all other Bamboos. It is, I believe, the only species of the genus of which the fruit is known, and helps to show how little is known at present of what the really perfect state of the spiculæ of the species of this genus, and several of *Melocanna* also, may prove to be.

Schizostachyum apus, Steud.	=*Bambusa apus*, Rœm. et Sch.
S. bitung, Steud.	=*B. bitung*, Rœm. et Sch.
S. capitatum, Rupr.	=*Guadua? capitata*, Munro.
S. durie, Rupr.	=*Bambusa Blumeana*, Sch.
S. iraten, Steud.	=*Melocanna Zollingeri*, Kurz.
S. Zollingeri, Steud.	=*M. Zollingeri*, Kurz.

XVI. Cephalostachyum.

Munro, nov. genus. *Schizostachyum*, Griffith, Icon. Pl. Asiat. 151; Notulæ, 64.

Spiculæ utrinque imperfectæ, in glomerulis plerumqne terminalibus, subglobosis subsessiles, fertiles cylindricæ, teretiusculæ, sub-3-floræ, flosculo inferiore unipaleaceo, penultimo tantum fertili, bipaleaceo, ultimo stipitiformi, tabescente, sæpe minuto. *Glumæ* aristatæ, gemmiparæ. *Palea* inferior (fertilis) subulato-acuta, membranacea, venosa, striata, sæpe venulis transversis anastomosantibus, dorso glabra vel hirsuta; superior plerumque longior, apice mutica, vel biaciculata, dorso profunde sulcata. *Squamulæ* 3, magnæ (nisi forsan in *C. Chapelieri*), apice fimbriatæ. *Stamina* 6, antheris obtusis. *Stylus* longus, rostro inclusus. *Stigmata* 2, plumosa, ramosa, ratione styli, brevissima. *Fructus* basi attenuatus, longe rostratus.

Gramina fruticosa vel arborescentia in montibus Indiæ orientalis et Birmah crescentia. Folia lanceolata vel ovata, petiolata, plerumque acumine longo sæpe hirsuto terminata. Inflorescentia semper capituliformis, plerumque terminalis, foliis superioribus quasi involucrata, ramulis inferioribus interdum verticillato-spicatis, in *C. pergracili* glomerulis secus ramos graciles dissitis, moniliformibus.

Griffith's drawing contains a very good analysis of the structure of this genus; and the description above given is principally extracted from his notes. In regard to the structure of the inflorescence, he says, "It is not difficult to conceive that the usual form is to have one terminal spicula, which, by the continued development of lateral flower-buds, subsequently assumes the anomalous structure and appearance of *Schizostachyum* described by Nees in Agros. Bras. p. 534."

Conspectus Specierum.

Capitula terminalia vel in ramulis inferioribus aphyllis subspicato-verticillata. Spicula fertilis 6–7 lin. longa, *vix exserta*, spiculis sterilibus numerosissimis bracteisque scariosis suffulta. Folia lanceolata . . . . . 1. *C. capitatum.*

Capitulum terminale. Spicula fertilis 12–14 longa, e sterilibus longe *exserta*. Folia lanceolata . . . . . 2. *C. pallidum.*

Capitulum terminale, magnum, 2 poll. diam. Spicula fertilis *brevis*, a *sterilibus* plerumque *superata*. Folia lata, ovata . . . . . 3. *C. latifolium.*

Capitulum terminale, foliis supremis intus *hirsutis conditum*. Spicula fertilis angusta (vix evoluta). Folia oblongo-lanceolata . . . . . 4. *C. Chapelieri.*

Species anomala. Glomeruli densiflori, secus ramos gracillimos, monilis more dissitæ. Spicula fertilis dorso hirsuta, pedicello terminali longo . . . 5. *C. pergracile.*

1. C. CAPITATUM, Munro. Culmo subarboreo, superne vagante, ramis laxis, glomerulis densifloris, plerumque terminalibus, folio suffultis et longe superatis; in var. β, ramulis inferioribus brevibus, aphyllis, glomerulos 2–3 superpositos ferentibus; spicula fertili *vix exserta*, palea inferiore mucrone brevi vel arista apiculata, rudimento terminali brevissimo, foliis lanceolatis. *Bambusa capitata*, Wall. et Griff. in Wall. Cat. 8913!

Hab. in Ind. or. montibus, Khasia, Churra, 4000 ped. s. m., *Wallich*! *et Griffith*, 1078! 1392! (in hb. Griff.), Nunklow ("Sillee et Sullea"), no. 1813!; Sikkim! 4000–6000 ped., Myong Valle ("Pyong"), *Hooker et Thomson*. Var. β, glomerulis basi aphyllis subspicatis, Churra! v. s.

"*Culmus* 12–30-pedalis, basi carpi diam., supra arbores pendens" (*Hooker*), ramis oligophyllis, apice sæpe capituliferis. *Folia* lanceolata, basi subrotundata, petiolata, apice setaceo-acuminata, utrinque glabra, margine aspera, $2\frac{1}{2}$–7 poll. longa, sæpe $1\frac{1}{4}$ poll. lata, nervis secundariis subinconspicuis, venulis transversis sat crebris, subconspicuis. *Vaginæ* glabræ, nitidæ, ore ciliis paucis caducis fimbriatæ. ligula brevissima. *Capitulum* densiflorum, plerumque castaneo coloratum, 1–$1\frac{1}{2}$ poll. diametro, spiculis sterilibus et bracteis longe aristatis, carinis serratis numerosissimis, *spiculis fertilibus paucis*. *Spicula* fertilis 3-flora, flosculo inferiore acuto, secund fertili subæquilongo, palea inferiore brevimucronata, superiore subobtusa, sulco dorsali hirsuto. *Squamulæ* 3, oblongæ, lanceolatæve, apice rotundatæ et breviter ciliatæ, supra medium 3–5-venosæ. *Stamina* 6. *Stylus* longus, primum rostro inclusus demum exsertus, hirsutus, apice bifidus. *Ovarium* in rostrum longum, glabrum, subangulatum attenuatum. *Fructus* maturus nunquam visus.

In var. β, collected at Churra Poonjee in 1830, some of the branches are very short, without any leaves, and bear 2–3 heads of flowers one above the other. These heads are much smaller than usual, but appear to have more perfect flowers in proportion to their size than the larger terminal head.

2. C. PALLIDUM, Munro. Culmo subarboreo, ramis, interdum numerosissimis, ad nodos verticillatis, capitulis pallidis, terminalibus, vix densifloris, spicula fertili sæpe pollicari et ultra, e reliquis sterilibus *longe exserta*, paleis inferioribus *longissime mucronatis*, foliis lanceolatis, $1\frac{1}{2}$–5 poll. longis. *Bambusa*, sp., Griff. Jour. 64.

Hab. in Ind. or. Mishmee! Birmah, Patkaye! 5000 ped. s. m. ("Betee Bans" incolis), *Griffith*. v. s.

Culmus subarboreus vel fruticosus, ramis valde inæqualibus, plurimis apice capituliferis. *Folia* lanceolata, plerumque brevia, 1–5 poll. longa, 5–10 lin. lata, basi rotundata, apice setaceo-acuminatissima (seta, in foliis parvis, longitudine $\frac{1}{3}$ laminæ æquante), pallida, utrinque glabra, sed supra, alterum marginem versus, scaberrima, marginibus aspera. *Vaginæ* glabræ, ore nudæ, vel interdum ciliis cito caducis fimbriatæ, ligula conspicua. *Capitulum* terminale, pallidum, vix densiflorum. *Spicula* fertilis e reliquis exserta, 12–14 lin. longa, 3-flora, flosculo inferiore unipaleaceo, multinervi, apice mu-

crone, 3 lin. longo, acuminato, secundo fertili pollicari, palea inferiore nervoso-striata, longe mucronata, superiore longiore, tenuimembranacea, multinervi, nisi sulco hirsuto glaberrima, genitalia involvente. *Squamulæ* angustæ, lanceolatæ, 5 lin. longæ, apice brevissime ciliatæ. *Ovarium* basi attenuatum, longe rostratum, rostro glabro incluso 12–13 lin. longum. *Stylus* breviter exsertus et cito 2-fidus. *Fructus* non visus.

This may probably be a more perfect state of *C. capitatum*, but it has a different appearance. The heads of flowers are of a much paler colour, and the fertile flower is very much longer. Griffith says that he found it commonly on the summit of the Patkaye range, on his journey from Naga to Hookhoom, and that it descended to a considerable distance on the southern side.

3. C. LATIFOLIUM, Munro. Culmo subarboreo ?, nodis sæpe hirsutis, capitulo fusco, magno, 2 poll. et ultra diametro, spicula fertili 6–7 lin. longa, *non* e spiculis sterilibus numerosissimis exserta, foliis *ovatis*, $2\frac{3}{4}$ poll. latis, ligula *elongata*.

Hab. in Ind. or. Bootan, no. 4 ! 2682 ! *Griffith.* v. s.

Folia latissima ovata, vel ovato-lanceolata, maxima 6–9 poll. longa et fere 3 poll. lata, basi rotundata, apice setaceo-acuminata, petiolata, petiolo utrinque transverse rugoso, flavescente, utrinque glabra, nervis secundariis, interdum utroque latere 18, conspicuis. *Vaginæ* superne striatæ, medio scabro-hirsutæ, fovea apicali magna, emarginata, ligula interdum valde *elongata*. *Capitulum* densissimum, terminale. *Spicula* fertilis 6–7 lin. longa, paleis genitalibusque iis *C. pallidi* similibus, sed fere duplo brevioribus. *Fructus* maturus glaberrimus, basi stipitatus, medio ovoideus, apice rostratus, cum rostro sub 6 lin. longus.

The foliage and ligules, combined with the smaller-sized fertile spiculæ, appear to keep this distinct from the two preceding species.

4. C. CHAPELIERI, Munro. Culmo tenui, scandente, nodis rugosissimis, capitulo terminali, foliis supremis intus hirsutis condito, spiculis fertilibus angustis, 5–6 lin. longis (vix maturis ?), foliis oblongo-lanceolatis, subtus linea obliqua tranversali notatis.

Hab. in Madagascar ! *Chapelier* in herb. Mus. Paris. v. s.

Culmus scandens, internodiis superioribus 2 poll. longis, scabris et scabro-hirsutis, ramis ad nodos biannulatos rugosos paucis, geniculatis, apice floriferis, $\frac{1}{2}$–1 ped. longis. *Folia* oblongo-lanceolata, coriacea, basi vix attenuata, nitida, 2–$4\frac{1}{2}$ poll. longa, 6–9 lin. lata, supra, nisi in foliis supremis involucrantibus, glabra, subtus, more insolito, lineis 1–2 hirsutis obliquis notata, margine serrata, nervis secundariis utroque latere 5–6, cum venulis transversis conspicuis. *Vaginæ* striatæ, marginibus dense fimbriatæ, ore auriculatæ, auriculis cito caducis, vix longis, ciliis etiam caducis fimbriatis. *Capitulum* multiflorum, breve, conditum, spiculis fertilibus 6 lin. longis, cum spiculis incompletis, subulatis, hirsutissimis, numerosis mixtis. *Spicula* (vix evoluta), 4-flora, flosculis 2 inferioribus unipalcaceis, 7–11-nervibus, apice in subulam hirsutam attenuatis, tertio fertili, bipalcaceo, terminali brevissimo, rudimentario. *Palea* inferior (fertilis) membranacea, brevimucronata, 5–7-nervis; superior convoluta, membranacea, apice bifida, acuminibus hirsutis, dorso canaliculata. *Stamina* 6, antherarum connectivo subelongato. *Squamulæ* fere obsoletæ, *inconspicuæ*. *Stylus* basi rostro ovarii inclusus, apice trifidus. *Stigmata* pulchre pinnata. *Ovarium* (immaturum) rostratum.

I have, through the kindness of M. Brongniart, been permitted to examine the specimen of this grass belonging to the Paris Museum, and have no doubt of its belonging

to the genus *Cephalostachyum*; but the specimen is from an immature state of the plant; and I did not consider myself justified in taking more than one spicula for examination. The inflorescence is so thoroughly concealed by the uppermost leaves, that no casual observer would perceive that the plant was in flower.

5. C. PERGRACILE, Munro. Culmo arboreo, ramulis floriferis gracillimis, tenuissimis, glomerulis spicularum, per intervalla 1–2 poll. distantibus, secus ramos dissitis, flore hermaphrodito hirsuto, palea superiore apice biaciculata, rudimento terminali longo.

Hab. in Ind. or. Tenasserim, Rangoon! *M'Clelland*; Pegu ("Tinwa," "Wablo" Karens), no. 11, *Brandis*. v. s.

"*Culmi* erecti, 40-pedales, dense cæspitosi, internodiis 18 poll. longis, circumferentia maxima 10-pollicari, spathis brevibus, 6 poll. longis, extus pilis atris tectis, margine fimbriatis, apiculo triangulari, cuspidato, reflexo, ramis inferne plurimis, sterilibus, rigidis, dense fasciculatis, apice spinescentibus" (*Brandis*). *Folia* lineari-lanceolata, plerumque 10 poll. longa, 9–15 lin. lata, basi attenuata in petiolum subtumidum et longitudinaliter rugosum, margine aspera, utrinque glabra (nisi pili pauci interdum subtus basin versus sparsi), nervis secundariis utroque latere 9. *Vaginæ* glabræ, ore ciliis paucis caducis fimbriatæ, ligula brevissima. *Inflorescentia*, ut videtur, *panicula* ampla, ramis simplicibus, 1–18 poll. longis, ad nodos numerosis, omnibus tenuissimis, filiformibus, glomerulos plerumque distantes ferentibus. Fasciculi spicularum bis terve divisi, in verticillis vel glomerulis dense aggregati. *Glumæ* inferiores gemmiparæ; superior oblonga, nervosa, margine longe fimbriata, flosculos basi circumvolvens. *Flosculus* inferior bipaleaceus, paleis hirsutis, inferiore acuta, nervosa, hirsuta, superiore breviore profunde sulcata, apice biaciculata, rudimento terminali longo, filiformi, raro, in flosculum bipaleaceum sed sterilem crescente. *Squamulæ* 3, angustæ, lineari-lanceolatæ, apice ipso sæpe obtusæ, multinervosæ, basi concavæ, margine tenuiter fimbriatæ, persistentes, fructu maturo adhærentes. *Stamina* 6, antheris obtusis. *Stylus* longus, basi rostro ovarii inclusus, apice in stigmata 3, revoluta divisus. *Fructus* maturus oblongus, nitidus, sine rostro 3 lin. longus, rostro glabro 3-lineali, subcompresso, subito mucronatus.

Brandis's herbarium contains numerous excellent specimens of this beautiful Bamboo, the branches of which are quite as slender as ordinary packing-thread, and yet bear numerous verticils, often an inch in diameter, with considerable intervals between them. The fascicles are more compound in this than in any of the other species of the genus, and often as much as in some species of *Melocanna* and *Schizostachyum*. The sterile spiculæ are not numerous.

XVII. PSEUDOSTACHYUM.

Munro, nov. gen. Tab. IV.

Spicula fertilis oblonga, sursum deorsumque imperfecta, intra glumas pedicellata, sub-4–5-flora, flosculo infimo 1-paleaceo, sterili, secundo et interdum tertio perfectis, bipaleaceis; penultimo masculo, bipaleaceo, cum terminali (tabescente, incompleto) cito caducis, pedicello relicto (fig. 2). *Glumæ* omnes gemmiparæ, vel pedicellos spicularum sterilium foventes. *Paleæ* glabræ, membranaceæ; inferior (fertilis) 5-nervis, margine fimbriata (fig. 2); superior plerumque longior, vix angustior, bicarinata, carinis superne tantum ciliatis (figg. 2, 4). *Squamulæ* 3, vel 4, vel 5, membranaceæ, obtusæ, apice fimbriatæ, persistentes, fructu maturo adhærentes (figg. 6, 7, 9). *Stamina* 6, antheris apiculo conico terminatis (fig. 3). *Stylus* rostro inclusus, longus (fig. 7), apice bifidus. *Ovarium* (figg. 5, 6) an-

gustum, lineari-oblongum. *Fructus* globosus, apice depressus, rostro contracto subito cuspidatus (figg. 8, 9).

Gramen subarborescens, in India orientali (Assam et Sikkim) indigenum. Folia lanceolata. Inflorescentia panicula supradecomposita, ramulis vel omnino floriferis, vel basi foliiferis apice floriferis, ad nodos fasciculatis, spiculis sæpissime morbosis et monstrosis, in fig. B bene delineatis.

Mr. Fitch's excellent drawing explains the inflorescence of this genus better than I could possibly succeed in doing in the most lengthened description.

Species unica tantum nota.

P. POLYMORPHUM, Munro. Culmi internodiis sæpe apice scabris, ramis paniculæ interdum longissimis, pendulis, sæpissime pseudospiculas (spiculas morbosas, steriles, polymorphas) ferentibus, spiculis fertilibus 4–5-floris, glabris, squamulis sæpe 5, foliis lanceolatis.

Hab. in India or. Assam, Nigrigam! Kujoodoo! et Tingrei! cum Thea associata, 1081! 1089! 1403! *Griffith*!; Sikkim, 4000–6000 ped. s. m. Balasur! Darjeeling! ("Mountain Bamboo," "Purphiok," "Partok"), *Hooker et Thomson.*

Culmi internodia sæpe 8 poll. longa, 3 lin. diametro, fistulosa. *Folia* oblongo-lanceolata, apice rostrato-obliquiacuminata, basi inæquilatera, vix attenuata in petiolum brevem, ima basi tumidum, 4–14 poll. longa, ¾–2 poll. lata, utrinque glaberrima, nervis secundariis utrinque 7–11, subconspicuis. *Vaginæ* striatæ, glabræ, vel primum hirsutæ et fimbriatæ. *Panicula* supradecomposita, ramis ad nodos numerosis, plerumque basi nudis, interdum oligophyllis, fasciculis sæpe iterum iterumque divisis, ad nodos ramulorum ultimorum alternis, spiculis fertilibus pedunculis elongatis sterilium sæpe stipatis. *Spiculæ* sæpissime morbosæ, nunc glabræ, curvatæ, squamis plurimis imbricatis, nunc globosæ, hirsutæ. *Spicula* fertilis et genitalia ut in genere descripta.

Perfect flowers are very rarely found in this species. I had seen numerous specimens collected by Griffith, and Hooker, and Thomson, and never could find a perfect flower; and the flowering branches were always more or less in the form represented at fig. B of Fitch's drawing. Thomson, however, collected some perfect flowers on his journey to Sikkim in 1857; and these are represented at fig. A. I have also seen some perfect fruit collected near Darjeeling in the same year by Mr. Hodgson.

In outward form these fruits are extremely like the seed-pods of *Anagallis* or of *Primula.* The change that takes place between the young ovary shown at fig. 5 and the perfect fruit (fig. 8) is very remarkable.

XVIII. TEINOSTACHYUM.

Munro, nov. gen. Tab. III. *Bambusæ*, sp., Thwaites.

Spicula pluriflora, sursum deorsumque imperfecta, cylindrica, attenuata, elongata, 1–2½ poll. longa, rhachillæ articulis sæpe longis et conspicuis, flosculis inferioribus 1–2 et superioribus 2–4 unipaleaceis, incompletis, intermediis 3–5 fertilibus. *Glumæ* 2–3, vel numero indefinitæ, plerumque gemmiparæ, semper distantes. *Palea* inferior basi involuta, medio lata, apice attenuata, plurinervis; superior brevior, vel longior, bicarinata, carinis ciliatis. *Squamulæ* 3, basi interdum concavæ; apice unica specie glabræ, unica fimbriatæ. *Stamina* 6, basi libera, antheris obtusis. *Stylus* longissimus, rostro ovarii inclusus (Tab. III. f. 5), deinde exsertus, apice 2–3-fidus. *Stigmata* tenuia, brevia, revoluta, cito caduca. *Ovarium* longissime attenuato-rostratum. *Fructus* bacciformis, rostratus.

Gramina fruticosa, vel subarborea, vel subscandentia, in India orientali (Burmah) et Zeylania indigena. Folia lanceolata, petiolata, venulis transversis nullis, vaginis ore fimbriatis. Inflorescentia spica subsimplex, ramulis nunc foliatis, nunc nudis terminalis, spiculis solitariis vel fasciculatis.

This is distinguished from all other genera of the section by the elongated spicula, with several perfect flowers and long joints of the rhachilla.

Conspectus Specierum.

Spicula $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, 5–11-flora. Squamulæ apice *glabræ* . . .	1. *T. Griffithii.*
Spicula 12–14 lin. longa, 5–7-flora. Squamulæ apice *fimbriatæ* . . .	2. *T. attenuatum.*

1. T. GRIFFITHII, Munro, Tab. III. Culmo gracili, internodiis apice scabriusculis, ramis fasciculatis, valde inæqualibus, spiculis spicatis, sæpe solitariis binisve, flosculis 3–5 fertilibus, squamulis glabris, vix acutis, foliis plerumque 5–7 poll. longis, vaginis ore longe fimbriatis.

Hab. in India or. Burmah prope Wulloboom "in sylvis collinis," *Griffith.* v. s.

Culmus gracilis, apice filiformis (fig. B.), vagans vel subscandens (pars superior 7-pedalis adest), internodiis 5–8 poll. longis, ramis ad nodos fasciculatis, valde inæqualibus, 2–12-pollicaribus, simplicibus vel compositis, floriferis nunc basi nudis, nunc foliatis (fig. A). *Folia* oblongo-lanceolata, plerumque $\frac{3}{4}$–$1\frac{1}{2}$ poll. lata, utrinque glabra, nisi interdum subtus basin versus subhirsuta, petiolata, apice attenuata, acumine scabro, nervis secundariis utrinque 5-6, parum conspicuis. *Vaginæ* glabræ. *Panicula* subsimpliciter spicata, ramis vel ramulis terminalis, spiculis vel solitariis vel binis ternisve, nunc imbricatis, nunc distantibus. *Spicula* $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, apice valde attenuata, 5–11-flora, flosculis 1–2 inferioribus brevibus, difformibus, sterilibus (unus del. in fig. 1), 3–5 sequentibus perfectis fertilibus, 2–4 supremis gradatim tabescentibus, rhachillæ articulis longis, conspicuis, glabris (figg. 1, 2). *Palea* inferior (fig. 1) basi involvens, medio lata, multinervia, apice acuminata, 7 lin. longa, glabra vel interdum margines versus pubescens; superior (figg. 1, 2) longior vel brevior, obtusa, bicarinata, carinis breviter ciliatis. *Squamulæ* (figg. 3, 4) lanceolatæ, glabræ, subæquales, nervosæ, nervis basin concavam versus subincrassatis. *Stamina* 6 (figg. 2, 3), basi libera, antheris obtusis. *Stylus* (figg. 5–6) longus, hirsutus, ovarii rostro glabro inclusus, tandem exsertus, apice 2–3-fidus. *Ovarium* (fig. 6) longe rostratum, apice attenuatum. *Caryopsis* fere matura (fig. 3) glaberrima, basi apiceque attenuata, longissime rostrata, rostro incluso subpollicaris.

2. T. ATTENUATUM, Munro. Culmo subarboreo, 12–25-pedali, apice interdum filiformi, internodiis apice hirsutis, ramis fasciculatis, breviusculis, spiculis in fasciculis parvis subspicatis congestis, spicula subpollicari, flosculis 2–4 fertilibus, squamulis apice fimbriatis, foliis 3–6 poll. longis, vaginis ore longe fimbriatis.—*Bambusa attenuata*, Thw. Enum. 375.

Hab. in Ceylon, prov. central., alt. 4000–6000 ped. s. m., 3255! *Thwaites, T. Thomson*! (var. spiculis plurifloris et culmo apice *filiformi*!). v. s.

Culmus mediocris, inermis, $\frac{1}{2}$–1 poll. diam., apice filiformis. *Folia* 3–6 poll. longa, 4–9 lin. lata, glabra, lineari-lanceolata, subabrupte acuminata, basi rotundata, petiolata, nervis secundariis utrinque 3–4, inconspicuis. *Vaginæ* sparsim pallide adpresso-pilosæ, margine ciliatæ, ore longe fimbriatæ. *Panicula* subsimplex, spiciformis, internodiis uno latere sulcatis, in ramis florigeris, fasciculatis, breviusculis vel brevissimis, foliatis vel basi nudis, terminalis, spiculis in fasciculos parvos congestis, vel raro superne solitariis. *Spicula* 12–16 lin. longa, angusta, attenuato-cylindrica, glabra, 5–7-flora, flosculo infimo 1 et superioribus 2–3 sterilibus, intermediis hermaphroditis, rhachillæ articulis

glabris, tenuibus, longis. *Palea* inferior 8–12-nervis, glaberrima, acuta, mucronata; superior brevior, bicarinata, carinis superne tantum inconspicue fimbriatis. *Squamulæ* 3, lanceolatæ, apice fimbriatæ, basi angustatæ et concavæ, nervosæ. *Stamina* 6, antheris mucrone brevissimo, obtuso appendiculatis. *Stylus* elongatus, apice in stigmata 3 plumosa divisus. *Fructus* rostratus, utrinque attenuatus, glaber, rostro incluso $4\frac{1}{2}$ lin. longus. (Diagn. præcipue ex descr. *Thwaites.*)

XIX. Beesha.

Rheede, Hort. Mal. v. 119, t. 60! bona (1685), sed non Kunth, 'Journ. de Physique' (1822), quæ est *Melocanna bambusoides*. *Ochlandra*, Thwaites in Enum. Ceylon Plants, 376. *Nasti*, sp., Kunth, Rev. Gram. i. 325, t. 75. *Bambos*, Du Petit Thouars, gen. nov. Madagasc. in Mel. de Bot. (1811), non Retz.

Spicula utrinque imperfecta, monoica (an semper?), cylindrica, fructifera plerumque multo major, pluriflora vel pauciflora, flosculis paucis vel plurimis, inferioribus unipaleaceis, neutris, penultimo bipaleaceo, hermaphrodito, rudimento minuto floris superioris tabescentis, hoc interdum obsoleto. *Glumæ* duæ. *Palea* inferior (fertilis) multinervia, membranacea, nunc dorso glabra, nunc setulis nigris obsita; superior plerumque longior, apice obtusa vel bimucronata. *Squamulæ plurimæ*, vel in *B. capitata* 6. *Stamina* 6–9 vel *plurima*. *Stylus* longus, apice in stigmata 3–4–5 divisus. *Fructus* majusculus, ovoideus vel oblongus, longe rostrato-acuminatus.

Gramina arborea vel fruticosa in India orientali (Malabar), Zeylania et Madagascaria indigena. Folia varia, magna vel parva. Inflorescentia plerumque terminalis, nunc laxe verticillato-spicata, nunc spiculis in apice ramulorum capitato-congestis.

Rheede's drawing is, considering its date, a very good one of the Malabar species; but there has been much confusion about his genus. Kunth, who, in 1822, was the first of modern writers who used the word, distinctly states that he applied it to *Bambusa baccifera* of Roxb.; and this mistake has been perpetuated by most authors, who have frequently applied the description of the fruit taken from Rheede's drawing to Roxburgh's plant; and, *vice versâ*, descriptions from Roxburgh's drawing of *B. baccifera*, only found in Eastern Bengal, have been applied to Rheede's plant, only found in Western India.

Conspectus Specierum.

Folia *angusta*. Spicula fertilis *major*, plerumque in ramulo brevi ad basin rami vel paniculæ locata. Squamulæ *plurimæ*. Stamina *plurima*, plus quam 6, antheris sæpe longe mucronatis	1. *B. Rheedei.*
Folia *lata*. Spicula fertilis in verticillis spicæ cum sterilibus mixta. Squamulæ et stamina *plurima*	2. *B. stridula.*
Folia *angusta*. Spiculæ fertiles apice ramorum capitato-congestæ. Squamulæ 3. Stamina 6	3. *B. capitata.*

1. B. Rheedei, Kunth, Enum. 434 (excl. syn. omn. nisi Rheede in Hort. Mal.). Culmo arborescente 16-pedali, ramis foliiferis floriferisque ad nodos intermixtis, spiculis dimorphis, fructifera sæpe solitaria, antheris sæpe longe apiculatis, foliis angustis.—*Rupr.*, *l. c.* 155 ad not. *Beesha*, Rheede, *l. c.*; Ray, Hist. ii. 1316. *Bambusa scriptoria*, Schleus., fide Dillwyn in index Hort. Malab. *Melocanna humilis*, Roep. in Trin. Clav. Agr. 115, non alior. nec. Trin. aliis locis. *M. Rheedei*, Steud. *l. c.* 332.

Hab. in Ind. or. Malabar; Cochin, no. 115!, 1347!, *Wight, Johnstone*! v. s.

Culmi internodia superiora, 4–2½ poll. longa, nitida, glaberrima, ramis simplicibus vel raro compositis, valde inæqualibus. *Folia* lineari-lanceolata, plerumque 4–5 poll. longa, sub 6 lin. lata, basi rotundata et petiolata, apice seta longa, scabra acuminatissima, utrinque glabra, sed supra uno latere marginibusque scabra. *Vaginæ* glabræ, ore ciliatæ, ligula brevissima. *Panicula* apice verticillato-spicata, nunc 1–2 nunc 4–5 poll. longa, rhachi glabra, verticillis sæpe imbricatis, nunc basi nuda nunc foliata, in his spiculæ omnes steriles, tametsi genitalia adsint. *Spiculæ fertiles*, ad eundem nodum culmi, in ramis brevissimis, 1–1½ poll. longis, subsolitariæ. *Spicula sterilis* cylindrica, sub 9 lin. longa; *fructifera* conico-ovata, 12–14 lin. longa, 3–4-flora, floseulis 1–2 inferioribus unipaleaceis, sterilibus, supremo vel rarissime 2 hermaphroditis, terminali tabescente nullo. *Paleæ* multinerviæ, glabræ, vel hirsutiusculæ, membranaceæ, inferiores subito mucronatæ; superior subobtusa. *Squamulæ* plurimæ, angustæ, apice fimbriatæ. *Stamina* plurima, 15–18, basi libera, antheris vel longe vel breviter apiculatis. *Stylus* longus, apice 3–4-fidus, stigmatibus plumosis. *Fructus* oblongus, apice longissime rostratus, rostro incluso 20 lin. longus.

This has a more delicate habit of growth than the succeeding species, and has very much the appearance in foliage of some of the Arundinarias. The general character of the plant is extremely well represented in Rheede's drawing.

2. B. STRIDULA, Munro. Culmo fruticoso, panicula in ramis foliiferis terminali, laxe spicata, rhachi *hirsuta*, spiculis sterilibus et fructiferis in *eodem glomerulo* aggregatis, antheris apice mucronulatis, foliis majusculis.—*Ochlandra stridula*, Thw. *l. c.* 376. *Bambusa stridula*, Moon's Cat. p. 26, teste Thw.

Hab. in Ceylon, 1044! *Gardner, Macrae*, 42! *Walker*, 1345! *Wight, Thomson*!; Ratnapoora ("Battagass") 241! *Thwaites*; Ind. or. Bombay, Kala Nuddi, 875! *Ritchie* (folia). v. s.

"*Frutex*, culmis suberectis, confertis, internodiis sæpe scabris." *Folia* late lanceolata, 8–10–12 poll. longa, 1¼–1¾ poll. lata, basi rotundata, vel attenuata in petiolum fuscum, apice setacco-acuminata, utrinque glabra sed aspera. *Vaginæ* plus minus hirsutæ, vel tandem glabrescentes, margine ciliatæ, ore sæpe biauriculatæ, et ciliis pallidis longis caducis vel persistentibus fimbriatæ, ligula brevi, truncata. *Panicula* terminalis, verticillato-spicata, 1–3-pedalis, spiculis in glomerulos parvos, subdistantes aggregatis. *Spicula* fertilis cylindrica, subpollicaris, acuta, 3–5-flora, floseulis 1–2 inferioribus glumis subsimilibus, sed longioribus, multinerviis, margine fimbriatis, apice mucronatis, penultimo fertili, pedicello rudimentario minimo vel fere obsoleto. *Palea* inferior (fertilis) 12–14 lin. longa, basi eximie membranacea, acuta, glabra, sæpe superne fusca, 30-nervia; superior subæquilonga, obtusa, dorso convexa, fere 18-nervia. *Squamulæ* 6–9 vel forsan *plures*, lanceolatæ, 1–5–7-nerviæ. *Stamina numerosa* (7–30), antheris utrinque bifidis, apice mucronulatis. *Stylus* longiusculus, rostro inclusus, in stigmata 4–5 brevissima plumosa divisus. *Fructus* ovoideus, stylo persistente indurato acuminatus, paleis squamulisque stipatus, rostro incluso 1½–2 poll. longus.

Thwaites says this is common in the warm and moister parts of Ceylon, and very abundant in the Saffragan district. The leaves make an excellent thatch.

3. B. CAPITATA, Munro. "Culmo *arboreo*, 50-pedali," spiculis fertilibus apice ramulorum capitato-congestis, sterilibus multo minoribus in fasciculis interrupte subpaniculato-spicatis, vel in fasciculis brevibus terminalibus, spicula fertili 16 lin. longa, palea superiore apice bifida, foliis lineari-oblongis.—*Nastus capitatus*, Kunth, Gram. i. 325, t. 75! Enum. 430, Suppl. 355; Rupr. *l. c.* 133, tab. xvi. f. 43; Steud. *l. c.* 333. *Bambusa capitata*, Willd. hb. 7013, teste Trin.

Hab. in Madagascar, *Du Pet. Thouars*; côté est (vulgo "Voulou"!), *Chapelier*!; île Nossi-bé! *Perville*, no. 1978!, et Nossi Camba, 1978–2! *Boivin* (hb. Mus. Paris.). v. s.

Culmus inermis, 4–5 poll. diam., ramis foliosis. *Folia* oblongo- vel lineari-lanceolata, 3–4½ poll. longa, 6–10 lin. lata, brevipetiolata, basi rotundata et parum obliqua, apice angustato-subulata, utrinque glabra. *Vaginæ* glabræ, sursum obsolete striatæ, ore pilis setosis fimbriatæ. *Spiculæ* fertiles in capitulum solitarium, terminale congestæ. *Spicula* fertilis basi lata, lanceolata, acuminata, straminea, nervoso-striata, setulis nigris obsita, *multiflora*, flosculis inferioribus 5–6 unipaleaceis, sterilibus, gradatim increscentibus, penultimo bipaleaceo, fertili, ad basin pedicello brevi vel longissimo, rudimentario aucto. *Palea* inferior (fertilis) flosculis sterilibus brevior, sed iis similis, ovato-oblonga, apice mucronata; superior longior, 15 lin. longa, dorso sulcata, bisubulata, multinervia, carinis brevissime ciliatis. *Squamulæ* 3, *breves*, nervosæ, oblique acuminatæ. *Stamina* 6, connectivo antherarum interdum elongato. *Stylus* longissimus, pubescens, superne trifidus. *Fructus* tereti-oblongus, sine rostro 7½ lin. longus, parum obliquus et subcurvatus, basi breviter stipitatus, rostro persistente acutato-subulatus.

This differs in some respects from the two preceding species; but I have but little doubt, after the examination which I have, through the kindness of M. Brongniart, been permitted to make of the specimens in the Paris herbarium, that it belongs to the genus Beesha, and that it is the species referred to by Flacourt, as already mentioned at p. 8. None of the specimens which I have seen would indicate that the plant ever attained the size mentioned by Kunth.

Species dubia.

4. B. ELEGANTISSIMA, Kurz, MS. in hb. "Caulibus tenuibus, gracillimis, altissimis, ramis terminalibus pendulis culmos truncosque arborum hosce sustinentes velantibus."—*Bambusa elegantissima*, Hassk. Pl. Jav. rar. 42; Miq. *l. c.* iii. 419.

Hab. in Java, in sylvis elatis ("Ulul"), *Hasskarl, Kurz*! (tantum spathæ hirsutissimæ). v. spathas.

I do not know what authority Kurz has for placing this plant in the genus *Beesha*.

BEESHA BACCIFERA, Schult. = *Melocanna bambusoides*, Trin.
B. FAX, Schult. = *M. humilis*, Roep.
B. HUMILIS, Kunth = *M. humilis*, Roep.

XX. DENDROCALAMUS.

Nees ab Esenb. in Linnæa, ix. 476 (1834). *Bumbusæ* sect., Ruprecht, Steudel, et auct. alior.

Spicula sursum deorsumque, vel deorsum tantum imperfecta, ovata vel oblonga, aut ovalis, acuta vel *obtusa*, pauciflora vel pluriflora, rhachilla *abscondita*, flosculis 1–2 inferioribus unipaleaceis, sequentibus 2–3 vel plurimis bipaleaceis hermaphroditis vel fœmineis, terminali tabescente, sæpe obsoleto, vel omnino deficiente. *Glumæ* duæ aut tres, 1 vel 2 sæpe gemmiparæ, suprema carinata et carina ciliata. *Palea* inferior plurinervia, plerumque ventricosa, chartacea vel membranacea, sæpe apice subulato vel spinoso mucronata, saltem in flosculis superioribus, dorso vel glabra, vel hirsuta, vel sericea, margine glabra vel ciliata; superior angustior, obtusa, paucinervia. *Squamulæ* veræ *nullæ*; rarissime, in speciebus 2, pseudosquamulæ fallaces in flosculis nonnullis videntur. *Stamina* 6, basi libera, antheris vel apiculo conico subobtuso, vel mucrone longo hirsuto terminatis. *Stylus* longus, filiformis, basi rostro inclusus, apice vel indivisus?, vel 2–3-fidus. *Ovarium* apice hirsutum, ros-

tratum, rostro nunc caduco, nunc persistente. *Fructus* bacciformis, oblongus, apice hirsutus, plerumque rostratus, rostro interdum deciduo.

Gramina arborescentia vel fruticosa, sæpius inermia, in India occidentali, Malacca, Java, et China crescentia. Folia nunc angusta, nunc lata et latissima. Inflorescentia in omnibus speciebus similis, nempe panicula composita, spiculis secus ramos glomerato-spicatis, glomerulis e verticillis multis in ramulo abbreviato valde approximatis derivandis.

This genus is distinguished from *Bambusa* by its fruit and the absence of true squamulæ. In all other respects it agrees with that genus.

Conspectus Specierum.

Folia plerumque angusta, nunquam lata (in *D. Parishii* ignota). Spicula *brevis*, pauciflora, antheræ *breviter apiculatæ*.

Palea inferior *spinoso-acuta* vel *pungens*, dorso *adpresse hirsuta*. Paniculæ ramis ultimis validis, glabris . . . . . 1. *D. strictus*.

Palea inferior mucronata, vix spinosa, dorso *sericeo-hirsutissima* . . 2. *D. sericeus*.

Palea inferior *fere glabra*, margine *fimbriata, colorata*, mucronata. Paniculæ ramorum internodia apice *prunioso-glauca*. Folia ignota . . 3. *D. Parishii*.

Palea inferior omnino *glabra, membranacea*, acuta; superior *æquilonga* vel *longior*, sæpe dorso ad basin *fissa*. Paniculæ ramis ultimis *elongatis pendulis* . . . . . 4. *D. membranaceus*.

Folia lata vel latissima. Spiculæ *breves*, verticillis *parvis*, secus ramos tenues, *pendulos*, elongatos dissitis . . . . . 5. *D. flagellifer*.

Folia lata vel latissima. Spicula *ovata* vel *oblonga*, plerumque *pluriflora*. Antheræ *longe* mucronatæ.

Spicula *ovato-acuta*, dorso *pubescenti-hirsuta*, 6–9 lin. longa . . . 6. *D. giganteus*.

Spicula *ovato-acuta*, dorso *lævissima*, 4–5 lin. longa . . . . 7. *D. Hookeri*.

Spicula *obcuneata*, apice *truncata, obtusa, glabra*, 3–5 lin. longa. Verticilli *densiflori* . . . . . 8. *D. Hamiltonii*.

Spicula *lato-ovata* vel oblonga, *obtusa*, dorso *pubescens*, 9 lin. longa . 9. *D. latiflorus*.

1. D. STRICTUS, Nees in Linnæa, ix. 476. Culmo subarboreo, alto, paniculæ ramis ultimis validis, internodiis apice, nisi in var. β, glabris, verticillis densifloris, interdum maximis, spiculis pallidis, palea inferiore (saltem in flosculis superioribus) dorso *hirsuto-pubescente*, apice spinoso-acuminata, *pungente*, foliis subtus *pubescenti-bus*.—Miq. *l. c.* iii. 421. *Bambusa stricta*, Roxb. Corom. Pl. i. 58 (quoad descrip., sed non quoad tab. 80 !, quæ est *Oxytenanthera Thwaitesii*, Munro); Hort. Beng. 25; Fl. Ind. ii. 193; Kunth in Jour. de Phys. 1822, 148; Enum. 431; Rœm. et Sch. *l. c.* vii. 1339; Rupr. *l. c.* 146, t. xii. f. 56; Steud. Syn. 330. *B. verticillata*, hb. Rottler, non Willd. *B. glomerata*, Royle hb. *B. hexandra* ! et *Arundo hexandra* ! Roxb. hb. *B. tanæa*, hb. Ham. in Wall. Cat. 5038 A ! *B. pubescens*, Lodd. et Lindl. in Penny Cyc. *Nastus strictus*, Sm. in Rees's Cyc. no. 2 (excl. syn. Lour.); Raspail, *l. c.* v. 442. *Munget*, Pluken. Mantissa, 28, t. 341. fig. 2 (bona) (teste spec. in Plukenet herb. in Mus. Brit.), vol. xcii. fol. 31; Roth. Nov. Pl. sp. 198.

Var. β forsan monstrosa, verticillis proliferis, paleis inferioribus nervosis, hirsutis, paniculæ internodiis hirsutis (hb. Roxburgh in hb. Kew.).

Hab. in India orientali, in siccioribus fere ubique, Bengalia, Behar, Dunwah Pass, no. 896, Panchadurma!, *Hooker*; Hurdwar, *Wall. Cat.* 5038 B!; Seharunpoor, *Watson*!; Himalaya, *Griffith*! *Madden*!; Kaleedongee, 311! 372! ("Kussub"), *Royle*; Kalka! *Thomson*; Kumaon, *Strachey*!; Mussooree! Debra Dhoon (var. antheris longe mucronatis), *Falconer*; Chumba, 206!, *Pinwell*; Punjab, *Aitcheson*!; Banda, *Edgeworth*; Nagpore! (Cent. Ind.), Madras, *Dr. Shuter*! 208; 1798! 3345! 3418! 3419!, *Wight*; Vizagapatam, *Russell*; montibus Nilagiri, *Schmidt*, *G. Thomson*! *Wight*!; Bombay, *Dalzell*!; Concan!, *Stocks*; Belgaum ("Chouga"), 821! *Ritchie*; Burmah, *Wall. Cat.* 5037! var. vaginis viscosis; Tenasserim, 26! *Falconer*! *M'Clelland*! ("Minwa"), no. 18! *Brandis*; Singapore! *Montgomerie*, var. verticillis maximis; Java, *Junghuhn*. v. s.

Culmus sæpe inermis, nunc suffruticosus, nunc subarboreus, nunc arboreus elatus, "8–10-pedalis in Behar" (*Hooker*); "in collibus 40-, in vallibus 100-" (*Brandis*); "dense cæspitosus, basi ramis fasciculatis, horizontalibus, rigidis, sæpe spinescenti-ramosis, interdum foliigeris tectus" (*Brandis*); spathis striatis, flavis, intus lævissimis, 8–10 poll. longis, apiculo adpresso, glabro. *Internodia* sæpe pedalia, plerumque glabra, fere solida. *Folia* lanceolata, basi rotundata, vel raro attenuata, brevipetiolata, apice tenuissime acuminata, 1½–10–12 poll. longa, 6–12–18 lin. lata, supra *aspera* et interdum hirsuta, subtus hirsuta vel tandem glabrescentia. *Vaginæ* plerumque hirsutæ, nunc *viscidæ*, nunc glabræ, ore ciliis paucis, cito caducis fimbriatæ, ligula brevi, producta, truncata. *Panicula* ramosa, ramis *teretibus* simplicibus, elongatis, nunquam pendulis, glomerulis spicularum sæpe densissimis, ½–1–2 poll. diam. *Spicula* ovata vel oblonga, 3–9 lin. longa, sæpe acutissima, flosculis 1–2 inferioribus 1-paleaceis, 2–3 superioribus bipaleaceis. *Palea* inferior (fertilis) ventricosa, subcoriacea, dorso hirsuta vel pubescens, apice spinoso-pungente subulata; superior angustior, obtusa, pubescens, inter carinas ciliolatas 2–4-nervia, (in flosculo supremo) dorso convexa, ecarinata. *Stamina* 6 (in flosculis quibusdam, sed raro, 3 rigidiora et mutila), connectivo in conum brevem, rarissime elongatum et mucronatum producto. *Stylus* longus, pilis hirsutus, apice bifidus. *Ovarium* rostratum, apice hirsutum, rostro subpyramidali. *Fructus* bacciformis, 3–4 lin. longus, ovatus, rostratus, rostro persistente, apice infra rostrum subhirsutus.

This very useful and strong Bamboo is generally known to Europeans throughout India as the male Bamboo, and is universally used for spear-staffs. It is extremely variable in the size of its foliage. The plant flowers frequently, if not every year, and does not die down after flowering, as is the case with so many Bamboos.

2. D. SERICEUS, Munro. Culmo subarboreo, paniculæ ramis ultimis validis, internodiis glabris, vel apice hirsutiusculis, verticillis vix 1 poll. diam., spiculis 3–5 lin. longis, palea inferiore dorso et margine pilis *subbulbosis*, *densis*, *sericeis barbata*, mucronata sed vix spinosa, foliis lineari- vel oblongo-lanceolatis.

Hab. in Ind. or. Bengalia, Behar, monte Parasnath, 4000 ped. s. m., *Thomson*! *Hooker*! (folia tantum). v. s.

Culmus ut in *D. stricto*, spathis striatis, margine longe fimbriatis, apices versus pilis bulbosis hirsutis, apiculo brevi, triangulari, acuto. *Folia* 5–15 poll. longa, 6–9 lin. lata, sæpe longe petiolata, utrinque vel subtus tantum hirsuta, cæteroquin ut in *D. stricto*. *Vaginæ* striatæ, margine fimbriatæ, lateribus sæpe dense pilis glandulosis hirsutæ, ore sparse et caduce fimbriatæ, ligula dorso hirsuta, plerumque ciliata. *Paniculæ* ramis solidis, glabris, ramulorum internodiis sæpe striatis, non nitidis, et interdum superne hirsutiusculis, verticillis globosis, densifloris. *Spicula* brevis, plerumque 3 lin. longa, nunc obtusa, nunc acuta, 5-flora, structura *D. stricti*. *Palea* inferior (fertilis) apice cucullata et mucronata, vel, in eodem verticillo, obtusa, dorso basi nudo, superne sericeo-tomentosa; superior carina

sericeo-tomentosa, inter carinas binervia. *Antheræ* nodulo obtuso terminatæ. Reliqua ut in *D. stricta*. *Fructus* non visus.

I have never seen this in flower except from Parasnath. Dr. Hooker collected the leaves there in February 1848; and Dr. Thomson found it in flower there in September 1858. It has a very different appearance from any form of *D. strictus*, of which, however, it may prove to be a silky variety, distinguished by its very long curious spreading silky pubescence. I cannot point out any distinction in the structure of the spicula, except that the upper palea of the terminal flower is keeled, and not convex, as it is in *D. strictus*.

3. D. PARISHII. Paniculæ internodiis apice *pruinoso-glaucis*, palea inferiore submembranacea, colorata, dorso glabra, margine *fimbriata*, antheris appendiculo obtuso terminatis.

Hab. in Ind. or. Punjab, Himalaya!, *Lieut. Parish.* v. flores sine foliis.

Paniculæ (rami 3 tantum adsunt) internodia striata, verticillis densifloris. *Spicula* 5–6-flora, flosculis 2 inferioribus sterilibus, 2–3 sequentibus hermaphroditis, terminali tabescente, vel minimo vel omnino obsoleto. *Palea* inferior (fertilis) multinervia, dorso striata, brevissima, subviolacea, margine fimbriata, intus hirsutiuscula, apice acuta, vix mucronata; superior obtusa, *margine* et *carinis* fimbriata, venulis paucis reticulatis. *Ovarium* (immaturum) hirsutum, rostratum. Reliqua generis.

The anthers of the flowers in this species have the blunt points which are found in the two preceding species. In other respects it resembles *D. Hookeri* and *D. Hamiltonii*.

4. D. MEMBRANACEUS, Munro. Paniculæ ramis ultimis tenuibus, sæpe pendulis, verticillis $\frac{1}{2}$–$\frac{3}{4}$ poll. diam., spiculis angustis, cylindricis, glabris, palea inferiore *glaberrima*, margine *nuda*, superiore interdum, *dorso* fere ad basin *bifida*, foliis angustis, lineari-lanceolatis.

Hab. in Ind. or. Martaban, Trogla, no. 5029!, *Wallich*; Tenasserim! *Brandis, Lobb*! (quoad flores; folia dubia). v. s.

Culmus arboreus?, ramis superioribus foliiferis tenuibus, basi incrassatis, simplicibus vel compositis. *Folia* 4–5 poll. longa, 4–6 lin. lata, basi rotundata vel attenuata, apice mucronata, supra et margine aspera, subtus hirsuta, petiolata. *Vaginæ* striatæ, fere ad basin solutæ, hirsutæ vel glabrescentes, ore ciliis subpersistentibus paucis fimbriatæ, ligula brevissima, obtusa. *Panicula* omnino generis, internodiis glabris, ramis plerumque tenuibus, glabris, verticillis sæpe distantibus, interdum ad nodos glomeratis, densifloris. *Spicula* palida, glaberrima, 3–4 lin. longa, 4–5-flora, flosculis 1–2 inferioribus sterilibus, 2–3 sequentibus bipaleaceis, terminali tabescente brevissimo vel nullo. *Palea* inferior (fertilis) *glaberrima*, ipso apice immerse nervosa, mucronata; superior sæpe longior, obtusa vel acuta, sæpe dorso usque ad basin fissa, inter carinas fimbriatas 3-nervia. *Antheræ* mucrone glabro, *brevi* apiculatæ. *Fructus* maturus ovatus, uno latere compressus, apice ipso tantum hirsutiusculus, rostro brevi persistente subito mucronatus, sine rostro 3 lin. longus.

This is distinguished from all the genus by the perfectly glabrous lower palea, combined with narrow leaves. . . . In Brandis's herb. no. 19, this was unfortunately mixed up with *Oxytenanthera albo-ciliata*, Munro; and I have in consequence not been able to derive any information as to the habits and size of the plants from Dr. Brandis's notes.

The leaves attached to Lobb's specimens are very different from the mature ones attached to Wallich's 5029, but they may possibly be young leaves from a young shoot.

5. D. FLAGELLIFER, Munro. Culmo arboreo, paniculæ ramis elongatis, 2–3-pedalibus et ultra, tenuibus, *pendulis*, internodiis uno latere sulcatis et hirsutis, spicula brevi, palea inferiore margine *fimbriata*, mucronata, foliis latis.—*Bambusa flagellifera*, Griffith, MS. in herb.; forsan *B. bitung*, Rœm. et Sch. *l. c.* 1354, et supra, p. 112. *Schizostachyum loriforme*, Munro, in hb. T. C. D.

Hab. in Malacca, *Griffith.* v. s.

Culmus elatus, internodiisjunioribus apice farinosis, ramus foliifer terminalis (1 tantum adest) $2\frac{1}{2}$ ped. longus, axillis ramos floriferos nondum evolutos ferentibus. *Folia* majora 10–12 poll. longa, 2–$2\frac{1}{4}$ poll. lata, supra glabra, nisi medio, præsertim basin versus, ubi denticulis parvis scaberrima, subtus tactu aspera et prominentiis minutis scabriuscula, ad costam pilis longis, interdum basin versus hirsuta, margine serrato-scaberrima, basi attenuata in petiolum sæpe scabro-hirsutum, apice longe acuminata, nervis secundariis utrinque 11–13, conspicuis. *Vaginæ* striatæ, medio pilis adpressis, albidis hirsutæ, superne glabræ, apice truncatæ, ore nudæ, margine uno fimbriatæ, ligula brevi, conspicua, truncata. *Panicula ampla*, internodiis plerumque apice scaberrimis, ramulis ad nodos numerosis, elongatis, *flagelliformibus*, pendulis, *filiformibus* sed validis, verticillis distantibus, vix 5 lin. diametro, internodiis omnibus uno latere *hirsutis*. *Spicula* brevis, ovata, vix 3 lin. longa, 5–7-flora, flosculis 4–5 bipaleaceis, terminali nunc minimo, nunc obsoleto. *Palea* inferior inconspicue 12–18-nervosa, dorso glabra vel raro subscabra, mucronata, margine breviter fimbriata; superior obtusa vel acuta, membranacea, carinis et margine fimbriata, inter carinas 1–2-nervia. *Squamulæ nullæ*. *Stylus* hirsutus, bifidus, interdum profunde. *Stamina* 6, basi libera, antheris seta vel pilis brevibus paucis (2–3) apiculatis. *Fructus* non visus.

This has smaller spiculæ than any species of the genus. It is very similar in many respects to *Bambusa Brandisii*, but has much smaller and less densely flowered verticils, and there are never the least traces of squamulæ. I have but little doubt that *B. bitung* of Schultes will prove to be the same species.

6. D. GIGANTEUS, Munro. Culmo excelso, internodiis apice glauco-pruinosis, verticillis approximatis, spiculis ovato-*acutis*, dorso *hirsutis*, plurifloris, antheris *acuminatis*, foliis interdum *maximis*, ligula *elongata*.—*Bambusa gigantea*, Wallich, Cat. Bot. Gard. Calc. p. 79.

Hab. in Pulo Penang, *Wallich*; Tenasserim ("Waklē" no. 10! "Wayā," ? no. 5), *Brandis*; cult. in Bot. Gard. Calcutta, *Thomson*! *Anderson*!; Hort. Sion! et Kew! v. v. et s.

Culmus maximus, interdum 26 poll. circumferentia, spathis variantibus, 9–12 poll. longis, intus glaberrimis, albicantibus, extus striatis, nunc pilis fuscis inferne hirsutis, nunc fere glabris, sed tactu asperis, apiculo lanceolato, sæpe spatham superante, plerumque reflexo, adpresso. *Folia* majora 12–20 poll. longa, usque ad 4 poll. lata, lato-lanceolata, basi rotundata, petiolata, supra glabra, subtus, in junioribus, pubescentia, demum glabrescentia, margine aspero-serrata, et basin versus sæpe longe fimbriata, nervis secundariis utrinque sub 16, venulis transversis crebris, parum conspicuis. *Vaginæ* sulcato-striatæ, demum glabræ, lateribus productæ, ore fimbriatæ, ligula *elongata*. *Panicula* ampla, ramis simplicibus vel compositis, nunc floriferis tantum, nunc apice foliiferis, sæpe apice *curvatis*, internodiis hirsuto-scabris, apice farinosis, verticillis plerumque approximatissimis, paucifloris. *Spicula* ovata, acuta, apice pungens, dorso pubescens, pluriflora, 6–9 lin. longa, flosculis 2–3 vel

pluribus unipaleaceis, sequentibus 2–4 bipaleaceis, fœmineis tantum (staminibus plus minus abortivis), penultimis 1–2 hermaphroditis fertilibus difformibus, terminali incompleto conspicuo, sæpe pungenti-acuto. *Palea* inferior, in flosculis fœmineis, dorso convexa, multinervia, mucronata, *adpresse hirsuta*, margine *efimbriata*, in hermaphroditis dorso plana et sulcato-plicata, apice breviter spinoso-acuta; superior dorso *hirsuta*, carinis longe fimbriata, nunc apice acuta, nunc *bicuspidata*. *Squamulæ* nullæ. *Stamina* 6, antheris apice acuminatis. *Stylus* longus, hirsutus, tandum 2-fidus. *Ovarium* hirsutum, longe rostratum. *Fructus* oblongus, $3\frac{1}{4}$ lin. longus, obtusus (rostro caduco), apice hirsutus, perigynio superne adhærente, tamen *inferne soluto*; hinc scutellum extus visibile est.

This splendid species is growing admirably in the palm-house at Kew. It appears to have flowered at Calcutta in 1861, thirty years after it had been originally introduced; and Dr. Anderson states that the specimen, although weakened, remained alive. It appears to me that the seed in this species is really enveloped in a perigynium, but that in the fertile flower this often becomes detached at the base, and shrinks up, forming a somewhat rugose hirsute crown to the fruit, and thus the scutellum becomes exposed to view; and I believe that the false squamulæ seen in one or two species are only the remains of the lower part of the perigynium.

7. D. Hookeri, Munro. Culmo arboreo, paniculæ internodiis lævibus, glaberrimis. verticillis densifloris, spiculis *ovatis*, *subacutis*, *nitidis*, palea inferiore vix acuta, lævissima, antheris apice *penicillatis*, foliis interdum latissimis.

Hab. in Ind. or. in mont. Khasia, Jasper hill! ("Ussey") 2000 ped., Nurtiung! 4000 ped., Nowgong! ("Denga"), Myrung ("Ussey") 5700 ped., Joowye! ("Ukotang"), cult. Bengal. Orient. no. 411! Pundua?, *Hooker et Thomson.* v. s.

Culmus 50-pedalis, cæspitosus, apice nutans, viridissimus, plumosus, 5–6 poll. diam., internodiis inferioribus subhirsutis, glaucescens, spathis magnis, basi 16 poll. latis, 10 poll. longis, extus pilis atris hirsutissimis, intus glaberrimis, apiculo lanceolato, 3–7 poll. longo. *Folia* lanceolata, 10–12–14 poll. longa, 2–$2\frac{1}{2}$–3 poll. lata, basi rotundata et breviter attenuata in petiolum brevem, latissimum, sæpe supra hirsutum, apice acuminatissima, supra glabra sed tactu aspera, subtus aspera, interdum hirsuta, vel ad costam, basin versus tantum, pilis sublongis hirsuta, margine serrato-aspera, nervis secundariis conspicuis, utroque latere 8–12–16; venulis transversis crebris, subconspicuis. *Vaginæ* inferne pilis adpressis hirsutæ, superne glabrescentes, truncatæ, ore nudæ, ligula conspicua, obtusa vel longe producta. *Panicula* composita, rhachi nitida, *lævissima*, verticillis densis, distantibus, vel raro approximatis, ramorum internodiis (interdum profunde) sulcato-striatis, hirsutis. *Spicula* ovata, vix acuta, lævis, $4\frac{1}{2}$ lin. longa, 4–5-flora, flosculis 3 bipaleaceis, terminali sæpe pedicellato, apice *pilis longis* barbato. *Palea* inferior (fertilis) chartacea, glaberrima, vix acuta, margine quam brevissime fimbriata; superior subacuta, carinis longe fimbriata. *Stamina* 6, antheris apice *penicillatis*. *Squamulæ* veræ nullæ; rarissime 1–2 pseudosquamulæ adsunt. *Stylus* longissimus, apice 2–3-fidus. *Ovarium* hirsutum. *Fructus* maturus non visus.

This is principally to be distinguished from *D. Hamiltonii* by the tapering polished spiculæ and smooth general rhachis.

8. D. Hamiltonii, Nees et Arnott, MS. ad Hamilton, Gram. Culmo *prælto*, paniculæ compositæ internodiis sulcato-striatis, aspero-hirsutis, verticillis *densifloris*, spiculis *obcuneatis*, apice obtusis, truncatis, *glabris*, palea inferiore margine fimbriata, an-

theris *mucrone longo hirsuto* appendiculatis.—*Bambusa maxima*, Ham. hb. 882, in Wall. Cat. 5039. *B. monogyna*, Griffith, Icon. cl. fig. 2, Notulæ p. 63, Itin. not. 110.

Var. *β. edulis*, Munro, spiculis plurifloris, pseudosquamulis 2–3, verticillis majoribus, foliis latissimis et tenuioribus.

Hab. in Ind. or. Assam, Goalpara, *Hamilton, Jenkins*! 189!, *Masters*, Gowahutty 641! 748! (in hb. Calcutta), Negrigam! Kujoodoo!, Bootan, 143!, Dewangiri, 2! 2680!, Mishmee, Ghaloom vicus, 10! 16! 18!, Sikkim, Darjeeling! *Griffith*; Sikkim ad 4000 ped. frequens ("Pao"), Yoksun! 5600 ped., Dubdi! ("Rugvet et Putu") (folia tantum), Darjeeling!, (var. *β*) Sikkim, Ramoon et Rato valibus! 4000 ped. ("Pao" et "Wah" pulluli juveniles edules), *Hooker et Thomson*. Kew cult. v. s.

Culmus 40–60-pedalis, ramis horizontalibus, internodiis brevibus, 4–5 vel 6–7 poll. diam., dense cæspitosus, parietibus crassis. *Folia* valde variabilia, lato-lanceolata, 4–16 poll. longa, 10 lin.–5 poll. lata, basi rotundata, interdum obliqua, supra glabra, subtus pallida vel concoloria, glabra vel hirsutiuscula, nervis secundariis utrinque 6–17, subconspicuis, brevipetiolata. *Vaginæ* superne glabræ, inferne pilis strigosis adpressis hirsutæ, ligula *elongata*. *Panicula* ampla, ramis erectis, sæpe fistulosis, rhachi scabra vel scaberrima, multisulcata, nodis hirsutissimis, glomerulis spicularum sæpe densissimis, raro proliferis, interdum $1\frac{1}{2}$ poll. diam., plerumque distantibus. *Spicula* fragilis, ovalis, compressa, 3–5 lin. longa, 4–5–6-flora, flosculis 2–4 bipaleaceis, penultimo difformi, fructifero, terminali nunc 1-paleacco, nunc ad pedicellum redacto. *Palea* inferior latissima, suborbicularis, scarioso-membranacea, interdum emarginata, marginibus fimbriata, multinervia, glabra; superior angustior, paulo brevior, dorso apicem versus sparsim pilosa, membranacea, inter carinas ciliatas 3–5-nervia. *Stamina* 6 vel raro 7, antheris rubro-purpureis (*Thomson*), connectivo in apiculum conico-subulatum, breviter pilosum producto. *Squamulæ* veræ nullæ; in var. *β* pseudosquamulæ 2–3 interdum adsunt. *Stylus* longissimus, apice trifidus. *Ovarium* ovato-conicum, hispidum. *Fructus* oblongus, apice hirsutus, rostratus, rostro sæpe persistente; interdum, non semper, perigynio inferne soluto, scutellum visibile est. Vide not. ad *D. giganteum*.

Dr. Hooker states that the young shoots of this species are eaten when boiled, and that the plants flower every year. The flowers, in the variety *D. edulis*, exhibit occasionally the most capricious variations: some flowers contain 3 stamens tolerably perfect, the remaining 3 being converted into style-like processes; sometimes there are two distinct styles, and sometimes the style is 4-cleft; occasionally there are 7 stamens.

9. D. LATIFLORUS, Munro, Tab. VI. Culmo *fruticoso*, fistuloso, internodiis brevibus, striatis, glabris, paniculæ ramosæ ramis simplicibus, 1–3–4 ad nodos (fig. B), $1\frac{1}{4}$–$1\frac{1}{2}$-pedalibus, internodiis apice incrassatis, uno latere sulcatis et hirsutis, verticillis paucispiculatis, spiculis sub 8-floris, latis, ovatis, *obtusis*, *pubescentibus*, palea inferiore margine fimbriata, antheris *longe mucronatis*.—*Bambusa verticillata*, Benth. in Fl. Hongkong, 434, non Willd.

Hab. in China, Hongkong, *Wright*!, 1050! *Hance*, 740! *Harland*; Formosa, no. 649! *Oldham*. v. s.

Culmus 6–7-pedalis et ultra. *Folia* (fig. c) lato-lanceolata, basi rotundata, vix attenuata, brevipetiolata, apice acuminatissima, utrinque glabra, margine aspera, 7–10 poll. longa, $1\frac{1}{4}$–3 poll. lata, nervis secundariis utroque latere 9, subconspicuis, ramulis transversis creberrimis, vix conspicuis. *Vaginæ* sulcato-striatæ, glabræ, vel inter strias pilis sublongis hirsutæ, ligula obtusa, truncata, *raro fimbriata*. *Panicula* (pars superior 4-pedalis adest) composita, spiculis in glomerulis, ramis approximatis, 3–6 vel superne solitariis. *Spicula* lato-oblonga (fig. I), 9 lin. longa et 6–7 lin. lata, compressa, sub-8-flora,

flosculis omnibus, nisi 2 inferioribus sterilibus, bipaleaceis, flosculo terminali tabescente, nullo vel raro obsoleto. *Gluma* superior (fig. 5) enervosa, obtusa, carinata, carina brevissime ciliata. *Palea* inferior (fertilis) (fig. 2) basi lata, sæpe plicata, multinervia, vix acuta, dorso *pubescens*, margine sæpe colorato-fimbriata; superior (figg. 2, 3) multo angustior, hirsuta, carinis fimbriata, apice breviter *bifida*. *Squamulæ* typicæ nullæ; rarissime, in spec. e Formosa, pseudo-squamulæ 1–2 adsunt. *Stamina* 6, e flosculis superioribus exserta, antheris mucrone *hirsuto longo* apiculatis. *Stylus* filiformis, longus, primum simplex, tandem apice bifidus. *Ovarium* (fig. 4) hirsutum, rostratum, stipitatum. *Fructus* maturus non visus.

This very pretty species seems well worthy of cultivation in our European gardens, as it doubtless flowers annually. Until Oldham's specimens were received, all hitherto known in herbariums were single branches of the panicle, and consequently the inflorescence was supposed to be simply spicate. I think it is very probable that this species is one of Rumphius's varieties of *Leleba*.

XXI. Dinochloa.

Büse, Pl. Jungh. 388; Miq. *l. c.* iii. 415. Tab. V.

Spicula deorsum imperfecta, parva, ovata, 3-flora, flosculis 2 inferioribus dorso nitidis, subobtusis, supremo perfecto bipaleaceo (figg. 4–5). *Glumæ* 2, obtusæ, glabræ, flosculis inferioribus similes. *Palea* inferior (flosculi fertilis) paucinervia, obtusa, dorso et margine glabra (fig. 5) vel dorso *hirsuta* (fig. 4) (in Cuming. no. 637); superior brevior, ovalis, obtusa, carinis ciliata (fig. 5) vel glabra (fig. 4). *Squamulæ* nullæ. *Stamina* 6, filamentis brevissimis, antheris apice conico-acuminatis (fig. 6). *Stylus* brevis, ovarii rostro inclusus, apice in stigmata 3, brevissima, villosa divisus (fig. 6). *Fructus* (fere maturus) ovalis et breviter rostratus, 1½ lin. longus (fig. 7), "bacciformis, et, ut videtur, intus carnosus" (*Sch.*).

Gramen alte (usque ad 50 pedes) scandens, in Java et ins. Philippinis et Andaman crescens. Folia lanceolata. Panicula supradecomposita, ramis iterum iterumque ramulosis, spiculis secus ramulos ultimos subverticillato-glomeratis.

This genus has the smallest spiculæ of any Bamboo; but, among the thousands which the specimens contained, very few were perfect.

Species unica.

D. TJANKORREH, Büse, Pl. Jungh. *l. c.*; Miq. *l. c.* Tab. V. Panicula maxima, divaricatissima, spiculis minimis, vix 2 lin. longis, secus ramulos subspicato-glomeratis, foliis basi leniter attenuatis, vaginis primum ore fimbriatis, ciliis cito caducis. —*Bambusa scandens*, Blume in litt. ad Nees in Bot. Zeit. 1824, 291. *Nastus tjankorreh*, Rœm. et Sch. *l. c.* 1358; Kunth, *l. c.* 430; Steud. *l. c.* 333. *Schizostachyum parviflorum*, Munro in hb. T.C.D. *Chusquea amplopaniculata*, Steud. *l. c.* 337; Miq. *l. c.* 414.

Hab. in ins. Philippinis, no. 637! *Cuming*; Java, monte Gedee, *Blume*; monte Salak, 4000 ped. s. m., *Kurz*! *Junghuhn*; Hort. Bogor. 798, *Zollinger*; ins. Andaman! *Kurz* (folia tantum). v. s.

Culmus scandens, internodiis ¾–1½ ped. longis, ramis fasciculatis. *Folia* plerumque 2–5 poll. longa et 8–12 lin. lata, in spec. ex Andaman ins. 10 poll. longa, 2¼ poll. lata, lanceolata, setaceo-acuminata, basi attenuata et brevissime petiolata, glabra et lævia, venulis transversis parum conspicuis. *Vaginæ* superiores glabræ, inferiores scabræ, ore fimbriatæ, ciliis cito caducis, ligula truncata, sæpe longa, fimbriata. *Panicula* amplissima, rhachi semitereti, asperrima, ramis interdum 3-pedalibus, in racemos simplices vel ramosos divisis. Reliqua generis.

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[* attached to some numbers indicates that reference should be made to the "Addenda et Corrigenda."]

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ADDENDA ET CORRIGENDA.

Page 1. "Rumph" in this and other pages should have been "Rumpf"

P. 4, line 21, *pro* three rupees *lege* one rupee

l. 33, hic et alibi, pro PLATONIA lege PLANOTIA.

P. 8, l. 2, *pro* Singalelah, a mountain on the Islumbo Pass, *lege* Islumbo Pass over Singalelah, a range of mountains

l. 39, *pro* the Mauritius *lege* Bourbon

l. 41, *post* also *insere* from the Mauritius

P. 13, l. 9, *post* transversis *insere* conspicuis vel

l. 22, *pro* 2–3 *lege* 3–5

l. 33, post 350. adde syn. *Thamnocalamus*, Falconer, MS.

l. 34, *post* pedicellata, *insere* $1\frac{1}{2}$–

l. 35, *intra* ( ), *cum* nisi 1–2 terminalibus *include* tabescentibus

P. 15, l. 30, *pro* 11 *lege* 6 l. 31, *pro* sub 6 *lege* 6–12 l. 32, *pro* 12 *lege* 10

l. 41, *post* 334; *insere* Elliott in Bot. of Carolina and Georgia, i. pl. 4. fig. 4.

P. 16, l. 3, post 7; insere *A. bambusina*, Trin. Fund. 97.

l. 8, *adde* v. s.

l. 14, *pro* ribus *lege* libus.

P. 17, l. 34 ad finem, *adde* Ledeb. Fl. Ross. iv. 395.

P. 20, l. 16, *pro* 475 *lege* 375.

P. 21, l. 7, *pro* spathulis *lege* spathellis; et ad calcem *adde*:—In speciminibus vegetioribus a Thwaites nuper missis sub nom. *A. latifolia* e Wattakelli, 6000 ped. s. m., folia oblongo-ovata, $6\frac{1}{2}$ poll. longa, 18 lin. lata, nervis secundariis utrinque 8 et pedicelli sæpe spiculis longiores sunt.

P. 22, *A. glaucescens* est *Bambusa nana*; vide p. 89.

P. 26, no. 19, insere synon. *Thamnocalamus ringala*, Falconer, MS. ined.—*Note*. All the preceding pages had been printed before I procured, through the assistance of Mr. Edgeworth and Professor Oliver, a copy of Falconer's unpublished description of his genus *Thamnocalamus*. This description, I now find, was undoubtedly made from specimens of *Arundinaria falcata*, of which Falconer's genus is consequently a synonym; and I am now responsible for the genus *Thamnocalamus* as it is described at p. 33.

P. 28, l. 7, *pro* may therefore *lege* proves to

l. 29, *pro* divisus *lege* diviso

P. 33, l. 22, *ante* Falconer *insere* Munro non; et quoad annot. ad calcem paginæ vide supra corrigenda ad p. 26.

P. 34, l. 12, *ante* v. s. *insere* Khasia, Kalapanee alt. 5300 ped. No. 1326! *Hooker* (folia).

P. 35, l. 35, pro *Japoniana* lege *Japonia*.

P. 38, no. 3, P. NIGRA, adde syn. *Bambusa nigricans* Hortul. teste Steud.

P. 39, no. 4, P. KUMASACA, adde syn. *Bambusa ruscifolia*, Sieb. MS. in hb. Kew.!

P. 41, l. 14, *pro* acuti *lege* acutis.

P. 53, in conspectu, *insere* 19 bis. *C. ligulata*. Vide p. 62. No. 20, pro *anelytra* lege *anelythra*.

P. 59, l. 7, *pro* 893 *lege* 892

P. 74, no. 1, N. BORBONICUS, adde syn. *Bambusa paniculata*, Willd. hb. teste Rupr.

P. 76, l. 10, pro *B. verticillata*, Willd., substitue *Gigantochloa verticillata*, Munro.

P. 85, l. 2, *post* pedales, *insere* (10–20-pedales teste *Gardner*)

P. 86, l. 5, *pro* fimbriata; superiore margine ciliata et brevialata, sæpe *lege* fimbriata, superiore (margine ciliata et brevialata) sæpe

l. 17, pro *Krueger* lege *Crueger* l. 31, pro *Sqamulæ* lege *Squamulæ*

P. 87, XI. BAMBUSA, adde syn. generis *Iscurochloa*, Büse, Pl. Jungh. i. 390; Miq. *l. c.* iii. 422.

P. 92, no. 3, B. NUTANS, adde ad finem:—Some of the specimens in hb. Brandis, No. 15, "Wapyoogyee," marked *B. arundo* Thomson, appear to belong to this species; but unfortunately some of the leaves in the same envelope belong to a decidedly distinct species.

P. 93, l. 40, *pro* margine *lege* margines versus

P. 97, l. 19, et p. 108, l. 40, *pro* uno margine *lege* unum marginem versus

P. 102, l. 10, *pro* Ann. vii. *lege* Ann. vi.

P. 105, l. 32, *post* India *insere* at Malda

P. 107, l. 4, *pro* Plant. et *lege* Plantarum

l. 19, adde syn. *Arundo bamboa*, Mill. Dict. ed. 8, no. 4, teste Sch. et Rupr. *l. c.* 160.

P. 111, no. 26, B. FORTUNEI, pone *Bürger* post *Mus. Brit.*

P. 113, no. 31, *pro* RITCHEYI *lege* RITCHIEI

P. 114, no. 33, *pro* Valley *lege* Valle

P. 121, no. 60, adde syn. *Melocanna excelsa*, Roep. teste Trin. Clav. Agros. 105. 60.

P. 124, no. 1, adde syn. *Nastus verticillatus*, Sm. in Rees's Cyc. no. 3, excl. syn. Lour.

P. 126, no. 4, *pro* A an *lege* An.

P. 131, ad no. 20, l. 23, pro "*plurimæ*" lege "plurimis"

W.H.Fitch, del et lith.

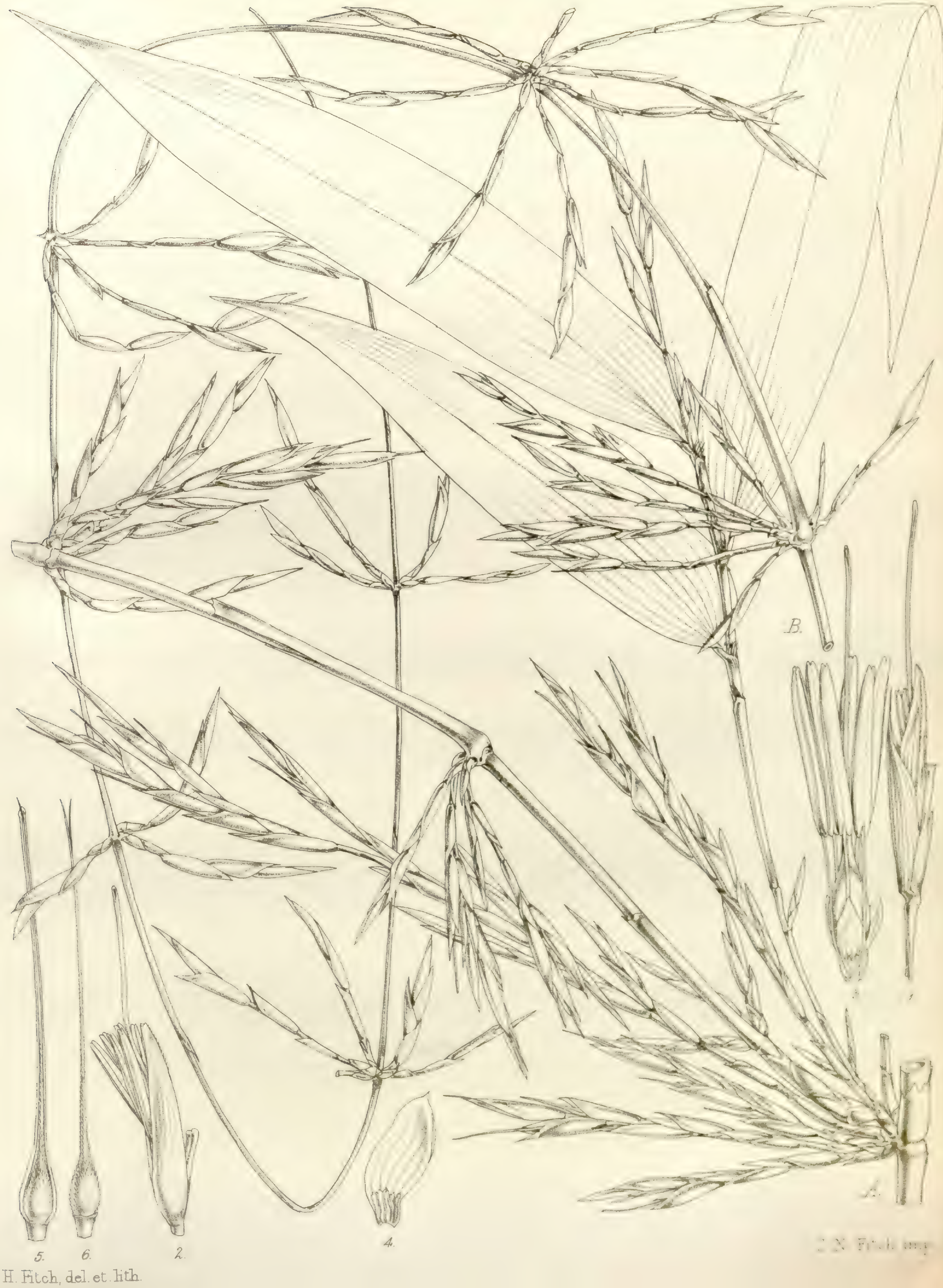
J.H. Ellis imp.

Arthrostylidium longiflorum, *Munro.*

W.H. Fitch, del. et lith.

J.N. Fitch, imp.

Chusquea simpliciflora, *Munro.*



W. H. Fitch, del. et lith.

J. N. Fitch, imp.

W H Fitch, del et lith

J.N. Fitch, im

W. H. Fitch, del. et lith.

W. H. Fitch, del. et lith.

II. *On the Genus* Crescentia.

By John Miers, *Esq., F.R.S. & L.S., Commend. Ord. Imp. Bras. Rosæ.*

(Plates VII., VIII., IX.)

Read May 2nd, 1867.

The genus *Crescentia* was considered by DeCandolle* to belong to a group of plants (the *Crescentieæ*) forming a second tribe of the *Bignoniaceæ*. This he again divided into two subtribes, *Tanaecieæ* and *Crescentieæ*,—the former being distinguished by its siliquæform fruit with two or more cells, and opposite leaves, the latter by a unilocular fruit and alternate leaves. This arrangement was founded upon much misconception, as it will be presently shown that scarcely any of the genera comprised in these groups bear any relation to *Crescentia*.

Dr. Seemann, in 1852†, gave a new outline of the entire group, and a somewhat different arrangement of DeCandolle's genera. He there adopted Gardner's view of making them a distinct natural order, the *Crescentiaceæ*, and raised the subtribes of DeCandolle to the rank of tribes, the *Tanaecieæ* being distinguished by having a regular, persistent, 5-fid clayx, and the *Crescentieæ* by having an irregular, spathaceous or 2-partite, deciduous calyx. In the Linnean Transactions, xxiii. p. 3, he gave a more extended diagnosis of the order within the boundaries he ascribed to it, comprising in his tribe *Tanaecieæ* the genera *Colea*, *Phyllarthron*, and *Tanaecium* (including in the latter the *Schlegelia* of Miquel), and placing in the *Crescentieæ* the genera *Parmentiera*, *Crescentia*, and *Kigelia*, giving at the same time the character not only of each genus, but of each species.

In 1861‡, I published some "Observations on the Bignoniaceæ," in which I pointed out the normal structure of the ovary, fruit, and seed of the various groups of the family; and (in p. 255) I commented on the *Crescentieæ* especially, and on its several genera, showing from my own investigations, and from the recorded observations of others, that all the genera of the *Tanaecieæ* and nearly all those of the *Crescentieæ* should be excluded from the true *Crescentieæ*, on account of their 2-locular ovary. In the 'Annals' of the same year (vol. viii. p. 113), I gave a detailed account of the structure of the flower, fruit, and seed of *Tanaecium*, showing it to be a true genus of the *Bignonieæ*, closely allied to *Adenocalymna*, and that the *Tanaecium parasiticum*, Sw., and *T. lilacinum*, Seem., belong to the *Schlegelia* of Miquel, a genus certainly distinct from *Tanaecium* on account of its seeds enveloped in pulp, and which, from its apparently 2-locular fruit, with seeds fixed upon the middle of the dissepiment, seems to belong to the same group that includes *Platycarpum*, *Henriquezia*, *Oxycladus*, and *Monttea*. I showed also that all the genera of the *Bignonieæ* and *Catalpeæ* have a 2-celled ovary and fruit, with the exception of *Jacaranda*, *Calampelis*, and *Eccremocarpus*, which I proposed to unite into a distinct

* Prodromus, ix. 240. † Botany of the 'Herald,' p. 181, and in Proceedings of the Linnean Society, ii. 268.

‡ Ann. Nat. Hist. 3rd ser. vii. 153.

tribe (*Jacarandeæ*), differing from the rest of the family in having a unilocular ovary and fruit, with parietal placentation: in that respect they offer some analogy with the *Crescentieæ*, from which they differ in their dry capsular fruit splitting into two valves, containing winged seeds imbricately attached to a parietal median line of placentation on each valve. In the structure of the flower and the ovary, there is little that can distinguish the *Jacarandeæ* from the *Crescentieæ*; but subsequently a notable difference arises, in the growth of the fruit, the former producing the development just described, while in the *Crescentieæ* we find a hard indehiscent 1-locular fruit, with numerous apterous seeds imbedded in pulp. The *Crescentieæ* have, therefore, scarcely higher claims than the *Jacarandeæ* to be separated from the *Bignoniaceæ*, unless it could be proved that the pulpy matter is formed by an arillus surrounding each seed, in which case there would be more valid ground for the maintenance of *Crescentiaceæ* as a distinct order.

Finally (in 1864) M. Bureau published his valuable monograph of the *Bignoniaceæ*, in which he suggests a new arrangement of the family, and where he constitutes the *Crescentieæ* the third tribe of the order. He follows the views of preceding botanists in classing in this tribe *Colea*, *Phyllarthron*, *Parmentiera*, and *Kigelia*, with *Crescentia*, under the persuasion that *Crescentia*, like all the others, has a 2-locular ovary (*l. c.* p. 56); but he confesses that he had not seen the ovary of any other species than *C. macrophylla*, where it is unquestionably 2-locular; and hence he naturally inferred that it was a mistake to regard the ovary of *Crescentia* as being 1-locular: it will, however, presently be shown that the species in question does not belong to that genus.

The learned DeCandolle, in his 'Prodromus,' was evidently doubtful in regard to this point of structure; but his son, the present eminent Professor in Geneva, stated (in a note) that the ovary is manifestly 1-locular in *C. cujete*, as Gardner had shown it to be in *C. cuneifolia*. Dr. Seemann, in his monograph of the *Crescentiaceæ*, did not dispute this fact, but considered it of such little importance that he classified indiscriminately with *Crescentia* six other genera, all with 2-locular ovaries. I examined with great care the ovary of *Crescentia*, from specimens preserved in spirits, in different stages of growth, and found it to be most decidedly 1-celled, without the slightest trace of any dissepiment; and the generality of this structure was again confirmed in the fruits of several species which I have since observed. In support of the same conclusion, Mr. Bentham has added his valuable testimony.

But there still remains another important desideratum, which is to ascertain the real structure of the fruit of *Crescentia*; for this has not yet been determined with any approach to accuracy. With this view, I procured from Brazil ripe fruits, which I was able to examine within a month after they were gathered. This fruit, which I had often seen growing in Rio de Janeiro, but to which I then paid little attention, considering it to belong to the well-known type of the genus described by Linnæus, pertains, however, to a species hitherto undescribed. It is nearly the size of that of the last-mentioned type, being regularly oval, $7\frac{1}{2}$ inches long, 6 inches in diameter, supported upon a thickened peduncle $1\frac{1}{4}$ inch long, 4 lines thick; the outer shell is rather thin in substance, of a texture between coriaceous and osseous, of the uniform thickness of 1 line, externally polished, yellowish green, without any removeable epidermis, marked by four equidistant,

longitudinal, almost obsoletely grooved lines, and punctured over its whole surface with numerous small immersed hollow dots; it is quite indehiscent. Internally it is filled with a fleshy uniform mass, without the appearance of any division; this pulpy mass adheres to the inner surface by means of several soft layers that run parallel with it, so that, on dividing the shell transversely, the upper moiety is easily detached from it, when it is seen to be quite smooth inside, without any projection or cicatrix to indicate the presence of any parietal placentation. The pulpy mass is not so easily separated from the lower half of the shell by the same method; for I found that it adhered firmly to the bottom; but, within the membranous layers that serve to attach the pulpy mass to the shell, a number of strong longitudinal cords were seen proceeding from the base, tapering upwards into fine threads, which scarcely reach the apex, apparently in a single series and about thirty or forty in number. When these cords are torn away from the pulpy mass, the latter is soon detached; and we then perceive that the cords all emanate from a prominent central knob in the base of the cell, over the point of insertion of the peduncle, radiating in all directions in about four superposed series, each cord being 1 or $1\frac{1}{2}$ line broad at its origin, tapering upwards into a thread, and consisting of a solid bundle of woody fibres sending out in all directions branches containing nourishing vessels; these soon anastomose everywhere, becoming imbedded in the innumerable fleshy laminæ radiating from the cords, all closely interwoven and agglutinated together, so as to form one uniform fleshy mass, without the trace of any division, as we find upon cutting the mass into sections. In the substance of these laminæ some hundreds of seeds are imbedded, each in a corresponding cell, polished inside, formed simply by the separation of the membranes; each seed is quite free from the cell, except at its minute hilar point, where it is connected with a thread of spiral vessels emanating from the vascular network diffused throughout the fleshy membranes: the seeds do not appear to lie in any determinate direction. From these facts it is evident that the fruit is completely unilocular, without the vestige of a dissepiment, and that the internal pulpy mass consists of innumerable agglutinated fleshy emanations from the placentary cords that spring from the base: it is also manifest that there is no trace of an arillus around the seeds.

The seed is obcordate, 4 lines long, nearly 3 lines broad, much flattened, with a thickened margin, marked on one face by the prominent line of the raphe, which runs from the apical sinus to a small hilum in its pointed basal extremity: the outer coat, or testa, is hard, coriaceous, finely rugose in radiating lines, is of a brown colour, and closely invests an inner membranaceous integument, which is of a smoky-white colour, having a small chalaza in the sinus of its cordate summit, and at the base is prolonged into a funicle-like thread, which terminates in the hilum. The embryo filling its cavity is without albumen, and consists of two white fleshy flattened cotyledons, which are transversely oval, with a shallow cordate sinus in the summit, and are deeply notched at the lower rounded extremity, where they are connected together by a small flattened quadrate radicle pointing towards the hilum, that fills the notch but does not project beyond it. Thus it is seen that in the texture of the integuments of the seed of *Crescentia*, and in the form of its exalbuminous embryo, there is much resemblance to the seeds of many of the *Bignoniaceæ*.

The circumstances attendant on the growth of the ovary, and the manner in which the fruit is developed, form a subject of much interest. As the ovary increases in size, the placentæ, which at an early stage appear solid and fleshy, gradually enlarge and become divided by numerous minute fissures, thus forming as many salient points along their surface, which as they expand become subdivided into very fine laminæ, between which the attached ovules by degrees become immersed, and which with the accompanying network of nourishing-vessels, are spread in all directions; and this process of subdivision and agglutination of the membranes into a solid pulp, continues nearly up to the period of the full-growth of the fruit. The main vessels, which at an early period served for the nourishment of the placentæ, remain almost in their original position, and finally become converted into the ligneous cords mentioned in a previous page. The same process of development takes place in fruits of a smaller size; but the cords just alluded to, being much finer, do not separate from the membranes which line the shell of the fruit.

One of the most remarkable features in the species whose fruit is above described, and which I have named *Crescentia plectantha*, is the singular deep transverse downward duplicature upon the ventral side of the corolla, a little below its middle. This character occurs in a less conspicuous degree in a few other species of the genus; it is very different from the upward ringent constriction below the lower lip in the tube of *C. obovata*, *C. cucurbitina*, and *C. coriacea*, and also from the circumambient throttling of the tube on the level of the insertion of the stamens, as shown in the drawings of Jacquin and Hooker.

Another characteristic feature observed in this species, and which may be supposed to be usual in *Crescentia*, is the mode of æstivation of the corolla, which, before expansion, is crumpled up into the smallest possible compass; the longitudinal corrugated plicatures of the tube, continued along the lobes, are, at that period, closely folded together, while the lobes themselves are suddenly bent inwards and downwards into the centre of of the tube, the crispate margins fitting into one another, with the superior lobe uppermost. This mode of æstivation, hitherto undescribed, is different from anything I have seen in the *Bignoniaceæ*; that of *Kigelia* comes nearest to it; but there the lobes of the border are quincuncially imbricated, at the same time that the lobes, as well as the tube, are tortuously and deeply corrugated; they are not plicated longitudinally as in *Crescentia*. The mode of æstivation of *Kigelia* as shown in Delessert's 'Icones,' therefore, conveys an imperfect idea of its real aspect.

Much intermingling of the species, owing to their imperfect descriptions, has everywhere existed, so that the character given of the type by different authors will scarcely enable us to recognize it. Five species were first indicated under Marcgraf's common name of *Cujeté*, by Plumier (in 1703), who, in his 'Genera,' p. 23, gave in a few words their differential characters, by which they may still be identified, though they have all since been confounded together. Sloane (in 1727) described two very distinct plants under the name of *Cucurbitifera*, which have been referred to other species of *Crescentia*. Linnæus (in 1753) in his first edition of his 'Species Plantarum,' named and indicated the genus *Crescentia* and its typical species. P. Browne (in 1756) in his 'Hist. Jam.' p. 265, described six species, four of which may be discriminated as belonging to the

genus. Burmann (in 1757) collected and edited the posthumous notes and drawings of Plumier, among which we find a valid but neglected species, *C. latifolia*, described and figured in tab. 109. Jacquin (in 1763) in his 'Stirp. Amer.' 175, tab. 111, published a drawing, accompanied by the most copious details on record, of Linnæus's typical species; and Linnæus in the same year repeated the short character of his type, in which he placed together, as its varieties, most of the previously recorded forms, at the same time expressing his doubt whether they might not prove to be specifically distinct. Swartz (in 1791) described fully his *Crescentia cucurbitina*, a plant which corresponds with Linnæus's var. δ, and with Browne's *Crescentia* No. 4. Kunth (in 1818) established his species *C. alata* and *C. acuminata*. Gardner (in 1840) described his *C. cuneifolia*. De Candolle (in 1845) enumerated seven species of the genus in his 'Prodromus,' from which two have since been excluded; he there repeated the errors in his references into which all other botanists had fallen. Mr. Bentham (in 1844) described and figured his *C. obovata*. Dr. Seemann (in 1854) gave the details of his *C. macrophylla*, which was figured in the 'Botanical Magazine,' and which will presently be seen not to belong to *Crescentia*. Dr. Seemann has written several memoirs on the *Crescentiaceæ*, the last being a monograph of the family upon the basis he had proposed, which was communicated to the Linnean Society (in 1859) and published in its Transactions; he there reduced the number of species of *Crescentia* to two (if we exclude his *C. macrophylla* and *C. alata*, H. B. K.); he justified this reduction solely upon the shape of the leaves, altogether ignoring the more discriminating characters furnished by the structure of the flowers and by the form and size of the fruit, characters which had been sufficiently well described by preceding botanists; in this manner he made *C. cuneifolia*, Gardn., and *C. acuminata*, H. B. K., identical with *C. cujeté*, and he declared *C. obovata*, Benth., and *C. latifolia*, Plum., to be the same as *C. cucurbitina*, Linn. I will, however, presently denote the differential features which give validity to all these several species.

In regard to *Crescentia macrophylla*, Seem., already alluded to, the valuable observations of M. Bureau upon its living flowers, confirmed by those of M. Baillon, show (Monogr. Bign. p. 118) that its ovary is decidedly 2-locular, with the ovules arranged longitudinally in four or six series in each cell, two or three being on the left, and the same number on the right-hand side of the dissepiment, as in *Kigelia*, *Colea*, &c. M. Bureau kindly sent me these analyses, which prove categorically, according to my view, that the plant in question does not belong to *Crescentia*, but will form the type of a distinct genus, to which the name *Amphitecna* may be given, and which will class in the same tribe as *Colea*, *Phyllarthron*, and some others.

M. Bureau has also favoured me with his analyses of *Colea involucrata*, Boj., *C. floribunda*, Boj., *Phyllarthron Bojeriana*, all from Madagascar, and *P. Comorense* from Mauritius: in all of these the ovary is manifestly 2-locular, with ovules arranged upon the dissepiment, in the same manner as in *Amphitecna* and *Kigelia*,—a structure quite incompatible with that of *Crescentia*.

The genus *Schlegelia*, erroneously confounded with *Tanaecium* by Dr. Seemann, and included in his family of the *Crescentiaceæ*, offers many very peculiar characters. M. Bureau has examined the ovary of *Schlegelia parasitica* in the living state, which he

finds to be unilocular, with two large placentæ in the centre almost touching, but not united, supported on two opposite longitudinal semidissepiments, so that in dried specimens the ovary appears 2-locular, as it does also in the ripe fruit. This structure is analogous to that seen in the baccate species of *Cyrtandra*; but it is attended by a very anomalous circumstance; for not unfrequently the ovary presents three similar semidissepiments, with as many placentæ almost meeting in the centre, but not united; and in such case, the style is always trifid. Swartz, in a remark upon the same species (Fl. Ind. Occ. p. 1054), though he figures the fruit as being completely 2-locular, says that he has often seen it to be 3-locular. This structure is quite unparalleled in the *Bignoniaceæ* and all its subfamilies, and points to a different affinity; for the normal development of its component carpels, according to the views suggested in my "Observations on the *Bignoniaceæ*," must be different from that in the other cases.

In *Kigelia* I had fancied that the ovary is 1-locular, or rendered sub-2-locular by the approximation of two opposite parietal placentæ, as described by Bojer, who had frequent opportunities for examining the living plant. M. Bureau has, however, shown me his analyses, where it is distinctly 2-locular, with the ovules congregated in three or four series on the margins, as in the true *Bignoniaceæ*, not in the middle of the dissepiment; and I have since clearly verified this structure in a specimen in the British Museum. The genus will therefore class with *Amphitecna*, *Colea*, and several others, distinguished by their fleshy subindehiscent fruit—among which *Parmentiera* will probably find its place.

It appears clear, therefore, that we know no genus that can class with *Crescentia*, which consequently will constitute a tribe near the *Jacarandeæ* and the *Cyrtandraceæ*, as they also have 1-locular ovaries. The former differ in their dry, 2-valvate, dehiscent capsules with winged seeds: the latter disagree in their free revolute placentæ attached to semidissepiments, the cell filled with hyaline mucilage, and numerous very minute foveated seeds suspended by a long funicle, and the embryo enclosed in very sparse albumen.

We may distinguish two very different forms of *Crescentia*: in one section the leaves are always fasciculated, out of a number of scale-like woody pseudostipules which fringe the axillary nodes, and which, upon the older branches, form a warty excrescence; the fruit is not umbonated at the summit; the pericarp is hard and very firm, even when it is very thin; the contained pulp, when much shrunk in drying, always retains, even after a period of fifty years, its soft subviscid consistence, and is composed of innumerable fine laminar membranes agglutinated together, containing spiral nourishing-vessels, and leaving numerous hollow dry cells polished inside, each provided with a seed; the seeds are $\frac{1}{4}$ or $\frac{1}{6}$ of the size of those of the following section, are very compressed, flat on the opposite faces, cordate at the summit, cuneate to the base, where by a minute hilum they are attached to the cell: the outer integument is hard and coriaceous, with a peculiar surface; the inner integument is very membranaceous, cordate at the summit, and suddenly contracted at the base into a long thread-like tube; the embryo is greatly flattened, is white and waxy, never becomes black in drying; the short radicle fills the sinus, and is not concealed by the auricular lobes of the cotyledons. In the other section (*Enallagma*), which may probably resolve itself into a distinct genus when the plants are better known, the leaves are always alternate, single, petiolated, articulated in the axil,

and exstipulate; the fruit is umbonated at the summit, the pericarp being generally very fragile; the pulpy matter, which I have seen only in the dried state, is of a different, somewhat pithy consistence, and, when moistened, seems composed of extremely elongated cells, apparently solid, flexible, and almost fibrous, intermixed with a few spiral nourishing-vessels, and not formed into distinct cells around the seeds. The seeds are many times as large, suborbicular, and but little compressed, with very convex faces deeply grooved along the middle, thus rendering them almost 2-lobed, and closely invested by two dark membranaceous integuments, the inner one in no degree contracted at the base: the hilum is not basal, but is seen upon one face above the lower sinus; the embryo is very thick and fleshy, very convex on both faces, deeply grooved down the middle, becomes very black in drying, the short radicle being entirely hidden by the auricular lobes of the cotyledons.

We have yet much to learn concerning the structure and growth of the ovary in this genus, especially in the species belonging to the section *Enallagma*, the fruit of which has not yet been examined in the living state. I believe, from all I have seen, that in *Eucrescentia* the ovary is invariably 1-locular, with four parietal seed-producing placentæ. In all the fruits I have examined, belonging to both sections, they constantly show four adnate parietal nervures, of which perhaps only two are sometimes placentiferous and seed-producing in *Enallagma*; but whether this be a constant or only a fleeting character, I have not the means of ascertaining. The only fact on record regarding the structure of the ovary in this latter section is that in *Crescentia obovata*, as described and figured by Mr. Bentham, it is 1-locular, with two slightly prominent parietal lines of ovuligerous placentation, but there are at the same time two other alternate prominent lines without ovules. In a very young ovary of a flower in bud of the same species, from Jamaica, I found it most decidedly 2-locular, with ovules attached to each side of the dissepiment. May it not be suspected from these observations that the ovary is at first 2-celled in the very young bud, but becomes unilocular by the time of the fall of the corolla? In support of this supposition I may add that in another ovary, examined after the fall of the flower (of *C. cuspidata*, from St. Vincent), I found it unilocular, with two opposite parietal ovuligerous placentæ, as figured by Mr. Bentham. It may also here be noticed that in a longitudinal section of a fruit, not quite matured, of *Crescentia elongata*, only half of which is glued to the paper, it is clearly shown that four distinct longitudinal cruciately disposed nervures exist, three of which remain, one having been removed with the other half of the fruit; of these, the two lateral ones are barren, but the intermediate broader line produces seeds imbedded in laminar expansions that emanate from it on both sides, which expansions are quite free from the lining of the shell at all parts except along that particular line of nervure. These are all the observations that the materials at my command have enabled me to make, owing to all the specimens examined being glued to the paper. I state them, however, with the view of inducing others to follow up an investigation worthy of further inquiry; the facts, though inconclusive, are certainly important, and require confirmation before we can attempt to draw any general inferences from them.

It would tend much to advance our knowledge of this interesting group of plants, if

correspondents abroad could be induced to send to Europe fruits accompanied by specimens of the plants, together with buds and flowers in different stages of growth preserved in spirits. This mode of inquiry would lead to more certain results, because the flowers in dried specimens become black and very brittle in drying, so that it is difficult to ascertain their characters with accuracy.

The species are certainly more numerous than are here enumerated, as shown by the fruits I have examined; for instance, in the British Museum there are two, collected in Peru by Ruiz and Pavon, to which they assigned the name of *Crescentia cujete*. One is quite pyriform, $4\frac{1}{2}$ inches long, 3 inches broad; the other is oblong, equally round at both extremities, $4\frac{3}{4}$ inches long, $2\frac{3}{4}$ inches in diameter, with seeds imbedded in pulp, and internally organized as I have described in *Crescentia plectantha*; in the one the seeds are rounded, in the other deeply emarginated at the apex. In the same museum are other, globular fruits of the genus, some with an extremely thick pericarp, and which cannot be assigned to any known species.

In the following enumeration I have excluded from the genus the *Crescentia alata* of Kunth, convinced that both it and *C. aculeata* belong to *Parmentiera*. Dr. Seemann came to the same conclusion with regard to the latter, but retained the former species in *Crescentia*. I have lately made a careful examination of the plants belonging to this group. In the Hookerian herbarium there is a specimen referred to *C. aculeata* of Kunth, which was collected in Mexico by Schiede (under his no. 1207); this is very different from one of another collection made by Schiede, now existing in the British Museum, which well agrees with *C. aculeata*, as well as with one from Zimapan (Coulter, 1007). I propose to distinguish Schiede's no. 1207 by the name of *Parmentiera foliolosa*; it closely approaches the *Crescentia alata* of Kunth in its alternate cupular nodes quite void of spines, with several 3-foliate leaves growing out of each axil; in the last-mentioned plant, which should now be called *Parmentiera alata*, we find generally in each axil one, sometimes two principal 3-foliate leaves, accompanied by two lateral simple leaves: in *P. foliolosa* we see three, sometimes four fasciculated 3-foliate leaves, generally without any simple leaves; they differ from the former in their smaller size, their submembranaceous leaflets, cuneately ovate, or obovate, upon a very narrowly winged petiole of nearly equal length, while in *P. alata* the leaflets are spathulately oblong, almost linear, coriaceous, upon a broadly winged petiole of twice their length: both species are without spines; and it is evident that to whatever group the former is assigned, the latter must accompany it. Now in *P. foliolosa* the flowers quite conform to those of *P. aculeata*; its calyx is pale, less fleshy than in *Crescentia*, and moreover, when closed in the bud, is terminated by a long slender rostrated apex as in *P. cerifera*, but it splits into three unequal divisions; the corolla, as in the other species of *Parmentiera*, is gradually campanulate, with a border of five subequal lobes, whose margins are crenately sinuated or crispate. If we examine *P. aculeata* attentively, we find that its axils are rarely quite opposite, and that in almost every cupular node formed by the spine, and which has a horny margin, there are always two 3-foliate leaves, often with a third, simple, smaller leaf, and that when the horny node is not spinescent at its outer extremity, as sometimes happens, it is cup-shaped and embraces the petiole of a 3-foliate leaf, and

adheres to it along the side of the hollow cup; from which we may infer that it is a true spine, not a prickle as Kunth defines it. In *P. aculeata* the mouth of the corolla is more oblique, more distinctly 2-lipped, the stamens further exserted, the anther-cells, pendent from an excurrent connective, are free, almost linear, somewhat divaricated, the style being of equal length; according to Kunth, the fruit is terete, narrowing at the summit; and Schiede says that it is oblong and costate*. *Parmentiera edulis*, DC., differs in its (single ?) 3-foliate leaves with ovate-oblong leaflets, acute at each extremity, upon a somewhat shorter and wingless petiole; its spathaceous calyx, as in *P. cerifera*, splits on one side only; its fruit is terete, sulcate, roundly costate, and 3 inches long. The *Crescentia edulis* of Desvaux appears to form another species of *Parmentiera*, to which the name of *P. lanceolata* may be given, and is distinguished by its simple (not 3-foliate) leaves, approximated, without any basal spines; it has a cylindrical, tuberculated fruit, 10 inches long, 2 inches in diameter, with very minute seeds and a firm fleshy pulp (or with a fleshy dissepiment as in *P. cerifera*?). In the last-named species the axils, as in *P. aculeata*, are not quite opposite, but they are spineless, each having always two, sometimes three, trifoliate leaves, with a very narrowly winged petiole; the calyx is elongated, spathaceous, with a long rostrated apex, and splits by a single fissure as in *P. edulis*; the corolla has five equal lobes, stamens hardly exserted, the fruit of the extraordinary length of 2 to 4 feet, scarcely an inch in diameter, and quite smooth. We thus find five very distinct species of *Parmentiera*, viz. *P. edulis*, *P. aculeata*, *P. foliolosa*, *P. alata*, and *P. lanceolata*.

1. *Eucrescentia*. Folia fasciculata.

1. Crescentia cujete, Linn. Sp. Pl. (1ª edit. 1753) p. 626; Jacq. Amer. (1763) p. 175, tab. 111, Fragm. 30. tab. 33. f. 5; Linn. Sp. Pl. (2ª edit. 1763) p. 872 (in parte); DC. Prodr. ix. 246 (in parte); Hook. Bot. Mag. tab. 3430; Seem. Linn. Trans. xxiii. 20 (in parte): 3-orgyalis, ramis crassis, longissimis, patentibus; foliis 5–6, fasciculatis, ob diversam ætatem inæquilongis, ex axillis nodosis pseudostipulatis alternis enatis, lanceolatis, imo longe cuneatis, apice gradatim acuminatis vel sæpe acumine brevi subito constrictis, sessilibus, utrinque glaberrimis: flore solitario, axillari, vel e ramis aphyllis enato, pedunculo breviusculo; calyce ovato, 2-fisso, lævi; corolla campanulata, tubo imo breviter angustato, mox latiore, et plica transversali introflexo, dein superne ampliato, gibbo, incurvo, longitudinaliter plicato-sulcato, fauce fere regulari, limbo 5-lobo, lobis inæqualibus, acutis, subexpansis, marginibus undulatis et inciso-laciniatis; staminibus paulo exsertis; stylo æquilongo; stigmate 2-lamellato; fructu maximo, ovato, pericarpio duro, intus pulposo.—In Antillis et Brasilia: *v. s. in hb. Mus. Brit.* inss. Santa Lucia, Jamaica &c.; Brasilia (*Blanchet*, 295): *in. hb. Hook.* St. Domingo (*Schomburgk*, A.D. 1857).

I have already mentioned the care I have taken to identify this species and, by giving it a more definite character, to extricate it from the confusion in which it has been

* Kunth, who never saw the fruit of *P. alata*, stated, upon the authority of Bonpland, that it was globular, and 4 to 6 inches in diameter: this was no doubt a mistake of Bonpland's, whose testimony is often doubtful.

involved. It forms an umbrageous tree, 20 feet high, with long, divided branches, which extend horizontally. The fasciculated leaves are of different lengths in each tuft, varying from $4\frac{1}{2}$ to $2\frac{1}{2}$ inches in length, or even sometimes less than an inch, and from 8 to 15 lines in breadth; they are glabrous, sometimes shining, bright green, gradually decreasing in breadth towards the base, where their entire margins are decurrent along the slender midrib to the point of its origin. The solitary flower springs out of the axils, or often from the trunk, at uncertain intervals, sometimes at a distance of only 3 inches from the ground. The peduncle is slender, 8 to 14 lines long. The calyx is 8–9 lines long. The tube of the corolla is $1\frac{1}{4}$ inch long, 4 lines in diameter at the base, thence suddenly enlarges, with a transverse duplicature 7 lines above the base, as shown in Schomburgk's specimen, not a circumambient constriction, such as appears in Jacquin's figures; it is 8 lines in diameter at the mouth; the lobes of the border are 5–8 lines long, 6–7 lines broad, acute at the summit, with the margins obtusely sinuato-crenate. The fruit is oval, often a foot in length. Schomburgk's specimen fully agrees with Jacquin's drawing of this species, and explains the real character of the constriction shown in the corolla, which in that drawing is doubtful and ill-defined; the specimens in the British Museum equally accord with that drawing, but the flowers, unfortunately, are all much eaten away or broken.

Jacquin, however, subsequently published the drawing of the flower of a plant cultivated in the Garden of Schönbrunn, which he doubtfully referred to this species. The flower is much larger, the calycine segments 10 lines long and much spread; the tube of the corolla, beautifully marked with reddish longitudinal stripes, is $1\frac{1}{2}$ inch long, more than twice the breadth at its base of that in the typical drawing, is 1 inch broad in the mouth; the lobes of the border are broader, more deeply and more acutely laciniated. Sir W. Hooker subsequently figured a plant grown at Kew, the flowers of which singularly resemble that of Jacquin's last drawing; the only difference is that the peduncle is shorter and stouter. There is no specimen of it in the Hookerian herbarium; but I noticed two loose flowers of it, which by mistake have been glued upon the same sheets as the specimens of *C. latifolia* from Jamaica, and of *C. cucurbitina* from Cuba. These flowers are probably those cultivated at Kew by Sir W. Hooker, and perhaps represent another species closely allied to *C. cujete*, but different from it.

2. Crescentia cuneifolia, Gardn. in Hook. Jo. Bot. ii. 422; DC. Prodr. ix. 246: *C. cujete*, Seem. (non Linn.), in parte (*loc. cit.* 20): *Crescentia* n° 1, Browne, Jam. p. 255: cortice cinereo, suberoso, rimoso, foveolato-punctato; ramis adscendentibus, ramulis patentim divaricatis; foliis e nodis majusculis compressis 2–8, fasciculatis, obovatis, apice abrupte breviter acuminatis, imo longe cuneatis, sessilibus, virentibus, supra nitentibus, glabris, subtus opace pallidioribus, præsertim in costa nervisque subpuberulis: floribus solitariis, rarius geminis, pedunculo medio 3-bracteolato; calyce ovato, in segmenta 2–3 subæqualia fere ad basin rupto; corolla campanulata, tubo extus glandulis minutis pellucidis punctato, ventre circa medium plica transversali signato, limbo 5-lobo, lobis valde acuminatis, marginibus irregulariter laciniatis, subbilabiato, labio superiore bilobo, lobis subplanis, inferiore trilobo, longitudinaliter plicato, lobo intermedio latiore; staminibus inclusis; stylo æquilongo;

stigmate late 2-lamellato; ovario 1-loculari, placentis 4 parietalibus cruciatim dispositis; fructu magno, valde globoso.—In Brasilia: *v. s. in hb. Hook.* Natividade, in prov. Goyaz (*Gardner*, 3342).

This species, though well described by Gardner, is considered identical with *C. cujete* by Dr. Seemann; but the only accordant feature that I can perceive is the laciniation of the border of the corolla, a character found in some other species; in all other respects there exists much discrepancy. It differs in the size and shape of its leaves, which are pubescent beneath on the midrib and nerves, in its more ovate calyx, in its included stamens and style, and in the globular shape of its fruit. The tree grows to the height of about 18 feet; the leaves are 4 to $7\frac{3}{4}$ inches long, $1\frac{1}{2}$ to $2\frac{3}{4}$ inches broad; the peduncle is about 7 lines long, the bracts small and acute; the calyx, at first closed and 9 lines long, splits into two or three unequal divisions; the corolla is greenish yellow, the lobes of the border nerved and reticulated with purplish lines; the fruit is perfectly globose, 6 to 8 inches in diameter. In Gardner's typical specimen, the transverse duplicature of the corolla which he mentions is not visible; but that, no doubt, is owing to the flower being glued to the paper on that side.

I have considered the species described by Browne to be the same as this, because it agrees with it in the form of its leaves and in the size and shape of its fruit.

3. Crescentia acuminata, H. B. K. iii. 157; DC. Prodr. ix. 246: *Crescentia cujete*, Seem. (non Jacq.) in parte, Linn. Trans. xxiii. 20: *Crescentia cujete*, var. β, *angustifolia*, Linn. Sp. Pl. 873: *Crescentia* n° 2, Browne, Jam. 266: *Cujete* n° 4, Plum. Gen. 23: ramis elongatis, flexuosis, ramulis angulatis, lævibus, glabris, subalbidis; foliis 3, fasciculatis, lanceolato-oblongis, apice acuminatis, imo longe spathulatis, cuneatis, sessilibus, integris, membranaceis, utrinque glabris, nervis divaricatis et remotiusculis, supra nitidis, reticulatis, subtus pallidioribus, costa prominente: floribus e trunco solitariis; pedunculo breviusculo; calyce coriaceo, glabro, 2-fisso, segmentis æqualibus, ovatis, obtusis, concavis; corolla subcampanulata, extus glandulis crystallinis scabrido-punctulata, tubo brevi, ventre infra medium plica transversali introflexo, fauce magna, subobliqua, limbo inæqualiter 5-fido, erecto; staminibus inclusis; stigmate 2-lamellato; fructu globoso, sub-4-pollicari.—In Antillis et Guiana: *v. s. in hb. Hook.* Karaoung, Guiana Gall. (*Sagot*, 451); sine loco (*Kokn.*).

This species, which is also amalgamated with the typical plant by Dr. Seemann, is well distinguished from it by its more membranaceous, narrower, longer leaves, and by its much smaller and globose fruit; Kunth makes no mention of the deep incisions in the border of the corolla, which is a marked feature in the two preceding species, but which I cannot trace in Sagot's specimen. The leaves are 2–6 inches long, 1–$2\frac{1}{8}$ inches broad; the peduncle is 7–8 lines long; the tube of the corolla is 4 lines broad at its base, $1\frac{1}{4}$ inch broad across its mouth, $1\frac{1}{4}$ inch long, with a transverse plicature 6 lines above the base; the upper lip is erect, $\frac{3}{4}$ inch long, divided into acute lobes, the margins of which appear very crispate. In the British Museum Collection there is a fruit, supposed to be from Jamaica, which corresponds with that described by Kunth: it is perfectly

spherical, 4 inches in diameter, supported by the persistent disk, is obsoletely 4-grooved towards the apex; the pericarp, half a line thick, is hard, smooth externally and closely pitted with concave semiimmersed glands, is lined inside with an adherent membranous plate formed of very thin laminæ, in which four thin equidistant flattened nervures rising from the base to the summit are imbedded; it is filled with a solid pulp, much shrunk in drying, but still soft, and composed of numerous laminæ agglutinated together, interspersed with numerous cells polished inside, twice the length and breadth of the seeds; the seeds are cuneately oblong, heart-shaped, greatly flattened, 3 lines long, $2\frac{1}{2}$ lines broad, with a firm rugose testa, a much shorter cordately orbicular tegmen suddenly narrowed below into a thread-like tube which terminates in the hilum; the cotyledons are white and of wax-like texture.

4. Crescentia confertifolia, nob.: *arbor cucurbitifera Americana*, Sloane, Jam. ii. 172: *Cujete* n° 5, Plum. Gen. 23: trunco lævi, albidulo, valde ramoso; axillis nodosis, subapproximatis, prominulis; foliis in nodis 7–8, fasciculatis, cuneato-oblongis, obtusis, fusco-viridibus, nitentibus: flore solitario; calyce 2-fisso; corolla campanulata, limbo valde laciniato; fructu mole mediocri, sphærico, seminibus cuneato-cordiformibus, valde compressis.—In Jamaica.

According to Sloane, this is a tree 20 to 25 feet high, with a trunk 6 or 7 inches in diameter, having a whitish smooth bark. It differs from the preceding in its much smaller leaves, which are comparatively broader and rounder at the apex. Seven or eight tufted leaves spring out of each node, these being 1 inch apart; they are dark green, smooth, and shining, 3 inches long, 16 lines broad; the peduncle is 1 inch long; the corolla is $1\frac{1}{2}$ inch long, of a dirty greenish colour, with a much laciniated border, speckled with brownish streaks: the fruit is spherical or somewhat oval, $4\frac{1}{2}$ inches in diameter; the seeds, like those of the foregoing species, are $3\frac{1}{2}$ lines long and 3 lines broad.

5. Crescentia plectantha, nob.; *Cresentia cujete*, Vell. (non. Jacq.), Fl. Flum. 269, vol. vi. tab. 103: 2-orgyalis, ramulis divaricatis; foliis 3–7, fasciculatis, e verruca squamosa ortis, lineari-lanceolatis, a medio ad basin spathulato-cuneatis, apice rotundatis, cum acumine subito brevi et obtusulo, sessilibus, submembranaceis, viridibus, supra glabris, subnitentibus, reticulatis, subtus pallidioribus, nervis tenuibus vix prominulis, costa subtenui prominente, obsolete puberula: floribus ex axillis vel e verrucis propriis solitariis, pedunculo circa medium 2-bracteolato; calyce imo subgloboso, mox latiore, et oblongo, in lobos 2 æquales fere ad basin fisso, vel hinc fissura unica, illinc in lacinias 3 tertia parte breviores irregulariter rupto, coriaceo, nitido, extus glandulis semiimmersis sparsim punctato; corolla imo coarctata, ultra calycem campanulata, antice et postice paulo compressa, dorso rectiore, ventre inflata, et hinc infra medium plica magna transversali profunde introflexa, longitudinaliter sulcato-corrugata, undique glandulis minutis carnosulis creberrime punctulata, limbo subobliquo, 5-lobo, lobis majusculis, fere æqualibus, subreflexis, acute acuminatis, marginibus integris, undulato-crispatis, 2 superioribus paulo majoribus et erectioribus, cunctis æstivatione profunde introflexis; staminibus ultra faucem vix exsertis; ovario oblongo, in discum magnum semicupularem

insito, 1-loculari, placentis 4, latis, cruciatim parietalibus; stylo æquilongo; stigmate magno, cuneato-oblongo, 2-lamellari; fructu maximo, oblongo-ovali, apice styli vestigio notato, imo disco indurato suffulto, pericarpio duro, minutissime impresso-punctulato, intus pulposo.—In Brasilia, prov. Rio de Janeiro.

This plant, hitherto undescribed, is quite distinct from any other species: it forms a tree about 12 feet high, with spreading branches, the trunk having a white coriaceous splitting bark, on which many parasitical plants grow. Velloz states that it is found both in the inland and maritime districts. Its most striking feature is the large size of its flowers, the wide and deep plicature of the corolla, which seems to be a general feature in all the species of this section. The leaves grow out of a warty excrescence on the branches, formed of concentrically imbricated woody stipuloid scales, each fascicle consisting of from 4 to 7 leaves of different ages, 4 to 8 inches long, 1 to 2 inches broad, the entire margin diminishing downwards, and decurrent along the midrib to the base. The flowers are solitary, most frequently growing from the trunk, out of a smaller nodose excrescence like that of the leaves: the peduncle is 6 lines long, with two small acute bracteoles in the middle. The calyx before expansion is solidly closed, semiglobose at base, then oblong-ovate, polished and punctated, about $1\frac{1}{2}$ inch long. The corolla is 3 inches long, cylindrical at its base for the length of 2 lines, where it is 4 lines in diameter; above this it becomes broadly and campanulately tubular, compressed antically and postically, with an oblique mouth nearly $1\frac{1}{2}$ inch broad: on the dorsal side it is nearly straight; but on the anterior side it is ventricose, and transversely plicated below the middle by the broad and deep downward fold above mentioned: the rather fleshy tube is smoother on the posterior side, but in other parts, as well as in the segments of the border, is plicato-sulcate lengthwise, all rugosely spotted with semiimmersed glands: the segments of the border, of which the two superior are somewhat larger and more erect, are of thinner texture, striately veined, 1–$1\frac{1}{4}$ inch long, 8 lines broad at their base, gradually narrowing into a very acuminate point, all with their margins entire, though undulately crispate; there is a reflexed tooth in each sinus between the lobes. The stamens are didynamous, with a very short rudimental fifth between the insertion of the posterior pair; the filaments are straight, thick, fleshy, subterete, and inserted 3 inches above the base in the mouth of the contracted portion of the tube, the posterior pair being $1\frac{1}{2}$ inch, the anterior pair $1\frac{1}{4}$ inch long; the anther-lobes are oblong, pendent, divaricated, attached at their apex, and there fixed on the summit of the filament, they are acute below, compressed, and burst along the outer margin by a thick sutural fissure, and finally become boat-shaped. The ovary is conically oblong, very smooth, 4 lines long, 2 lines broad, is 1-locular, with 4 very distinct longitudinal broad parietal lines of placentation, which project far within the cavity of the cell, and are covered with innumerable black shining minute ovules; the style is nearly erect, curving a little backwards, and as long as the stamens; the stigma 2-lamellar, submembranaceous, pointed, 5 lines long, 3 lines broad, papillous within. The fruit has already been described.

6. Crescentia fasciculata, nob.: ramulis subangulatis, cortice pallide brunneo, ruguloso, sulcato; axillis cupuloso-nodosis, prominentibus, alternis: foliis in fasci-

culo 5–6, sessilibus, oblongis, a medio ad basin gradatim spathulato-cuneatis, apice obtuse rotundatis, vel sensim acutis, minute mucronatis, glaberrimis, supra læte viridibus, reticulatis, subtus pallidioribus, crebre punctatis, nervis subdivaricatis paulo prominulis intra marginem arcuatim nexis, marginibus revolutis: flore solitario, pedunculo ad medium 2-bracteolato; calyce usque ad basin 2-fisso, carnosulo, impunctato; corolla campanulata, imo breviter tubulosa, dein ampliata, infra medium transversim duplicata, extus undique verruculis minutis scabrido-rugosa, ore valde obliquo, limbo 5-lobo, sub-2-labiato, lobis inæqualibus, 2 superioribus erectioribus, cunctis profundissime incisis, laciniis longis, linearibus; antheris vix ultra faucem exsertis; ovario oblongo, in discum cupuliformem carnosum margine crenulatum insito.—In Antillis: *v. s.* insula Sancti Thomæ, ad Boboni (*Ærsted*).

This species in some respects corresponds with *C. cuneifolia*, but differs in its smaller leaves, and in its corolla, the lobes of which are divided almost to their base into 3 or 4 very long, narrow, linear segments, in which respect it resembles *C. obovata*; but there the segments are two-thirds shorter and broader. The branch is 2 lines thick, 3 lines broad at the cupular nodes, which are $\frac{3}{4}$–1 inch apart; the leaves are $1\frac{3}{4}$ inch long, 7–12 lines broad; the peduncle is 6 lines long; the fleshy calyx, 9 lines long, is split to the base into two nearly equal obtuse segments; the tube of the corolla is 1 inch long, the basal contracted portion being 3 lines long, and $2\frac{1}{2}$ lines in diameter, and the transverse duplicature 6 lines from the base; the lobes of the border are 3 lines long and broad, exclusive of their segments, which are quite linear, 9 lines long, and $\frac{1}{2}$ line broad.

7. Crescentia aggregata, nob.: *Cucurbitifera Rhamni facie*, Sloane, Jam. ii. 175, tab. 228: truncis circiter 6 ex ipsa radice simul enatis, sesquiorgyalibus, erectis, superne ramosis; ramis patentibus, copiose foliosis; ramulis brevibus, cupuloso-nodosis, foliis paucis munitis vel subnudis, hinc pseudospiniformibus; foliis subparvis, ex axillis nodosis 4–8, fasciculatis, sessilibus, oblongis, imo breviter angustioribus, apice rotundatis vel obtusis, fusco-viridibus, nitentibus, glabris: floribus e trunco vel ex axillis ramorum, solitariis; pedunculo folium æquante; calyce 2-fisso; corolla pedunculo dimidio longiore, striis sordide brunneis signata, limbo guttato, valde laciniato; fructu globoso.—In Jamaica.

This is a species evidently intermediate between the preceding and the following, in regard to the size of the leaves. Sloane describes it as having several trunks springing from the same root, 9 or 10 feet high, and 4 or 5 inches in diameter, covered with a white smooth bark, with several branches standing out horizontally, with prominent axils 3 to 6 lines apart, each furnished with a tuft of leaves, which are sessile, 1–$1\frac{1}{2}$ inch long, 5–7 lines broad, with rounded summits; the branchlets are very patent, not more than $1\frac{1}{2}$ inch long, with few leaves, and, terminating in an obtuse point, are almost like as many spines; and hence, when there are a number of them close together, the branches appear prickly. The peduncle is 1 inch long, the corolla $1\frac{1}{2}$ inch long.

8. Crescentia linearifolia, nob.: *Cujete* n° 3, Plum. Gen. 23: ramulis subangulatis, subsulcatis, cortice pallido, coriaceo, laxiusculo; axillis alternis, approximatis, cupuloso-nodosis; foliis in axillis 6–12, fasciculatis, parvulis, linearibus, apice sensim

acuminatis, acute mucronatis, imo cuneatis, sessilibus, subcoriaceis, glaberrimis, supra viridibus, subtus paulo pallidioribus, utrinque nervis venisque reticulatis prominulis, nervo marginali subrevoluto: flore solitario; pedunculo ad medium 2-bracteolato: fructu parvo, globoso, vix sesquipollicari, apice obsolete cruciatim sulcato, styli vestigio notato, imo disco indurato stipitato et calyce brevi persistente ad basin inæqualiter fisso suffulto; pericarpio duro, subcoriaceo, fusco, nævis flavidis maculato, minutissime impresso-punctulato, intus placentis 4 parietalibus longitudinalibus costæformibus cruciatim dispositis adnatis, membrana fusca adhærente nexis.—In Antillis: *v. s.* ins. S. Thomæ, ad Boboni (*Ærsted*).

In the peculiar shape of its leaves, and in its very approximated nodes, this species bears no resemblance to any other of the genus. The branch is $2\frac{1}{2}$ lines in diameter, with large projecting cup-shaped nodes, 2 to 6 lines apart, out of which issue 6 to 12 fasciculated leaves of various ages and sizes, the older ones being 2 inches long, 2 lines broad, the younger 9 lines long, $1\frac{1}{2}$ line broad, all more or less divaricated. The fructiferous peduncle is 6 lines long, 1 line thick: the fruit is quite globose, scarcely $1\frac{1}{2}$ inch in diameter, supported by the indurated disk 3 lines high and $4\frac{1}{2}$ lines in diameter, and surrounded by the ruptured calyx; the pericarp is $\frac{1}{3}$ line thick, hard, subpolished, closely dotted with minute hollow punctures, and is marked inside by four prominent adnate ribs united at the base and apex and connected together by a dark-coloured adhering laminar coating.

9. Crescentia spathulata, nob.: foliis e nodis cupulosis 5–6, fasciculatis, sessilibus, spathulato-oblongis, apice rotundatis, apiculo brevissime mucronatis, a summo ad basin gradatim cuneatis, lateribus fere rectis, supra viridibus, glabris, subtus pallidioribus, ad costam utroque latere tomentoso-pubescentibus, et in nervis utrinque 20 divaricatis et arcuatim nexis puberulis: flore solitario; pedunculo brevi, subtenui; calyce subbrevi, in lobos ovatos fere ad basin 2-fisso, glandulis sparsis immersis punctato; corolla campanulata, longitudinaliter striata, glandulis minutis crystallinis scabrido-punctulata, tubo lato, subbrevi, infra medium plica transversali deorsum profunde introflexo, limbo sub-5-lobo, lobis deltoideis, acutis, marginibus undulato-crispatis, suberectis; staminibus inclusis.—In Ecuador: *v. s. in hb. Hook.* Ecuador (*Sinclair*): *in hb. Mus. Brit.* sine flore (*Linden.*, an cult. ?).

This species is well marked by the peculiar shape and pubescence of its leaves. The alternate cupular nodes are 1 inch apart, and fringed with several short ligneous stipuloid scales, generally prevalent in the plants of this section. The leaves on each fascicle vary much in size according to their age, and are remarkable for their very elongated form with rounded apex, and for the unusual number of the puberulous nerves beneath, while the midrib has a narrow band of soft pubescence along each side; they are 6–7 inches long, $1\frac{1}{4}$–$1\frac{1}{2}$ inch broad, the younger leaves sometimes only $1\frac{1}{2}$ inch in length. The peduncle is 5 lines long; the calyx 8–9 lines long, with broadly ovate lobes; the corolla is very like that of *C. plectantha*, but smaller, the tube being $1\frac{1}{4}$–$1\frac{1}{2}$ inch long, $\frac{3}{4}$–1 inch broad in the mouth, with a deep transverse downward duplicature on the ventral face 6–8 lines above the base, the lobes of the border being 5–6 lines long and broad.

2. *Enallagma.* Folia alterna. An genus distinctum ?

10. Crescentia cucurbitina, Linn. Mant. 250; Sw. Obs. 234; DC. Prodr. ix. 246; Seem. Linn. Trans. xxiii. 19; Gaertn. Fruct. iii. 230, tab. 223; Lunan, Hort. Jam. i. 141: *Crescentia* n° 4, Browne, Jam. 266: *Crescentia cujete*, var. δ, Linn. Sp. Pl. 873: trunco mediocri; ramis adscendentibus (nec patentibus), strictis, striato-angulosis, cortice laxo, suberoso; foliis alternis, approximatis vel sparsis, ovato-oblongis, imo subcuneatis, apice breviter acuminatis, subcoriaceis, glaberrimis, supra subnitidis, pallide viridibus, nervis immersis utrinque circiter 10, reticulatis, subtus glauco-pallidioribus, petiolo brevi, crasso: floribus terminalibus, 2–5, segregatim solitariis, nutantibus; pedunculo petiolo longiore, tenui, imo 2-bracteolato; calyce longo, late tubuloso, glabro, virescente, impresso-punctato, fere ad basin 2-fisso, segmentis late ovatis, concavis; corolla campanulata, scabrido-punctulata, tubo et fauce albidis, ventre rubicundo, limbo fusco, tubo imo subdilatato, paulo supra basin constricto, dein superne gradatim ampliato, antice ventricoso et infra faucem transversim plicato, limbo obliquo, 2-labiato, labio superiore indiviso, emarginato, crenato-undulato, brevi, inferiore longiore, latiore et 3-lobo, lobis brevissimis, angulatis; staminibus longioribus, faucem attingentibus; filamentis teretibus, paulo curvatis; antheris 2-lobis, lobis oblongis, divaricatis, fuscis; ovario subrotundo, depresso; stylo filiformi, exserto; stigmate 2-lamellato: fructu corticoso, ovato-oblongo, apice breviter umbonato; pericarpio sublignoso, vix fragili, intus pulposo. —In Antillis: *v. s. in hb. Mus. Brit.* Jamaica (*Wright*); *in hb. Hook.* Cuba Oriental. (*Wright*, 361); Panama (*Fendler*, 210).

This species does not appear to have been figured, with the exception of its fruit, and seems to have been confounded with *C. latifolia*; and therefore its characters as given by modern botanists cannot be relied on; that of Swartz is the only one on which we can depend. Swartz describes it as a tree of middle height, with a smooth trunk, its branches being erect, not spreading horizontally, and straight and angular. It grows in arid stony places, near the seashore, in Jamaica. The leaves, near the summit of the branches, are alternate, 2–3 lines apart, they are $4\frac{1}{2}$–$7\frac{1}{2}$ inches long, 2–$2\frac{3}{4}$ inches broad, on a thick petiole 2–3 lines long. The peduncle of the flower is $1\frac{1}{4}$ inch, of the fruit 2 inches long; the concave segments of the calyx are $1\frac{1}{4}$ inch long, 6 lines broad; the tube of the corolla is $1\frac{1}{2}$ inch long, with an oblique mouth 1 inch broad, a little below which it has a transverse ringent upward duplicature on the ventral side; the upper lip of the border is $\frac{3}{4}$ inch long, extremely broad; the lower lip is $\frac{1}{2}$ inch long, with 3 short broad lobes. The fruit, of which I have seen a specimen in the British Museum, is shaped exactly like that figured by Gaertner, is $3\frac{3}{4}$ inches long, 3 inches in diameter, supported by the persistent lignified disk, upon a somewhat slender peduncle; the pericarp is somewhat thinner than is shown in Gaertner's drawing, is hard, and can scarcely be called brittle, pitted externally with numerous very deep dots, internally is lined with a pithy submembranaceous laminar polished coating, in which 4 main placentary nerves, cruciately disposed, are imbedded, the intervening spaces being filled by a reticulated network of branching fibres. The seeds are fewer in number, and much larger, than those in the preceding section, and are well

figured by Gaertner; they are nearly orbicular, somewhat compressed, emarginated at top and bottom, with a deep groove along each face, are 7 lines long, 8 lines broad, covered by two integuments, both equally membranaceous, which closely invest the embryo: the latter, which grows black in drying, consists of two fleshy cotyledons of the shape and size just described, the bottom emargination being formed by two auricular lobes, beneath which the included short radicle lies quite concealed.

When Gaertner stated that the fruit is sometimes a foot long, this was not from his own knowledge, but from the account of authors who have confounded the species together. Swartz does not allude to this excessive magnitude, but, on the contrary, quotes as his only synonym Browne's short diagnosis, in which he describes it "fructu minori." Dr. Seemann amalgamates with this species *C. latifolia* and *C. obovata*, which are certainly distinct; he also quotes as synonyms *C. toxicaria* and *C. lethifera*, both figured by Tussac in his "Flore des Antilles;" but I have not been able to procure a sight of that work, to enable me to form an opinion upon these plants: the latter would seem to be a distinct species, or probably referable to another genus, on account of its trigonous fruit; and both are reputed to possess poisonous qualities, which are not ascribed to *C. cucurbitina*.

11. Crescentia obovata, Bentham, Voy. Sulph. 130, pl. 46: *C. cucurbitina*, Seem. (in parte), *l. c.* p. 19 (non Linn.): ramulis crassiusculis, striatis, subangulatis, ad originem squamulis numerosis brevibus acutis persistentibus instructis; cortice suberoso, laxo: foliis alternis, obovatis, apice acumine obtusulo brevi subito constrictis, imo cuneatis, breviter petiolatis, crasso-coriaceis, supra nitidulis, nervis immersis, subtus glauco-pallidioribus, nervis utrinque 10–12 costaque crassiuscula prominentibus: floribus in apice ramorum solitariis vel 2–3, subnutantibus, pedunculis longiusculis, validis, rectis, ebracteolatis; calyce crasso-coriaceo, glandulis minutissimis scabrido-punctulato, imo tubuloso, mox dilatato et oblongo, primum clauso, demum ad medium subæqualiter 2-fisso; corolla infundibuliformi-campanulata, incurva, extus minute scabrido-punctulata, ventre gibboso, infra faucem hinc subito transverse constricto, dorso lævi, fauce ampla, valde obliqua, limbo brevi, expanso, subreflexo, rarius obsolete lobato, margine fimbriato aut denticulato-crenato, reticulato-nervoso; staminibus inclusis; filamentis æqualibus, rectis; antherarum lobis parvis, oblongis, imo divaricatis; ovario oblongo, in discum magnum pulviniformem insito, 4-sulcato, 1-loculari, placentis 2 longitudinaliter parietalibus; stylo tubi longitudine, erecto, imo tumidulo; stigmate ovato, subsolido, apice breviter fisso, intus papilloso.—In Antillis: *v. s. in hb. Hook.* insula Gorgonia versus Veraguas, in maritimis (*Barclay*); S^a^ Anna, Jamaica (*Purdie*).

This species differs from the preceding in the shape of its corolla, its almost ringent oblique mouth, with a very narrow fringed border, in its stamens, its almost solid stigma, and several other characters. Its ovary has only 2 placentæ. The leaves are $4\frac{1}{4}$–$7\frac{1}{2}$ inches long, $2\frac{1}{2}$–4 inches broad, on a petiole 2–3 lines long: the peduncle is $1\frac{1}{4}$–$1\frac{3}{4}$ inch long; the calyx, before bursting, is $1\frac{1}{4}$ inch long, $4\frac{1}{2}$ lines in diameter at its base, 7 lines in its broadest part, the length of the segments being 10 lines; the tube of the corolla posteriorly is 2 inches long, anteriorly $1\frac{5}{8}$ inch long, 4 lines broad at base,

1 inch in diameter in the mouth, having, 3 lines below this, a very shallow ringent constriction, or upward induplicature of the tube, on the anterior side only; the stamens are 8 lines long, one pair being seated 5 lines lower than the upper pair, and 4 lines higher than the sterile stamen, which is fixed 6 lines above the base; the disk is 1 line high, 4 lines in diameter; the ovary is 5 lines long, the style is 15 lines, the stigma $1\frac{1}{2}$ line long.

12. Crescentia latifolia, Plumier, Amer. ii. 100, tab. 109; Lam. Dict. i. 558, tab. 547: *Crescentia ovata*, Burm. Fl. Ind. 132: *Cujete* n° 2, Plum. Gen. 23, tab. 16: *Crescentia cucurbitina*, DC. in parte (non Linn.), Prodr. ix. 246; Seem. in parte (non Linn.), Linn. Trans. xxiii. 19: trunco crasso, cortice rufo-cinereo; ramis patentibus, cinereo-glaucis, subangulatis, striolatis, nodis cupulosis margine cartilagineis; foliis alternis, ovatis aut oblongis, apice acumine brevissimo obtusulo constrictis, imo subacutis aut obtuse cuneatis, integris, glaberrimis, valde coriaceis, supra subpallidis, opacis, nervis immersis, subtus nervis utrinque 10 costaque prominentibus, petiolo brevi, crasso: floribus ramorum apicem versus vel in axillis solitariis vel binis; pedunculo subtenui; calyce oblongo, paulo supra basin ampliore, ultra medium æqualiter 2-fisso aut in segmenta 3 inæqualia rupto; corolla campanulata, tubo longitudinaliter sulcato, antice ventricoso, et hinc medium versus plica transversali profunde introflexo, fauce paulo obliqua, limbo 5-lobo, lobis subbrevibus margine inciso-laciniatis, laciniis linearibus, acutis aut obtusis; staminibus paulo exsertis, antheris imo divaricatis; stylo multo longiore; stigmate ovali, subsolido: fructu majusculo, ovato, apice breviter umbonato, pericarpio sublignoso, fragili, intus pulposo.—In Antillis: *v. s.* ins. S. Thomæ, ad Borboni (*Ærsted*): *in hb. Hook.* Cuba (*Otto* 357); Jamaica (*Distin*).

This species much resembles in general appearance *C. cucurbitina*, with which it has been confounded by most botanists, but differs in being a larger tree with a thicker trunk, and with copious wide-spreading (not erect) branches, in its leaves, which are more cuneate at base, its more erect flowers, a differently shaped corolla, with a deep ventral transverse duplicature (not ringent in the mouth), its broader and 5-lobed border with laciniated margins, a subsolid stigma, and a larger fruit. Plumier describes it as an "arbor ingens;" the trunk often acquires a considerable diameter, and furnishes a pale-coloured, hard wood, with a close crossgrain, which renders it valuable for many purposes. The leaves are 5–$7\frac{1}{2}$ inches long, $2\frac{3}{4}$–$3\frac{1}{2}$ inches broad, on a thick petiole $\frac{1}{2}$ inch long. The peduncle is 1–$1\frac{1}{2}$ inch long; the calyx is broad, $1\frac{1}{4}$ inch long; the tube of the corolla $1\frac{1}{2}$ inch long, 1 inch broad in the mouth, and below the plicature in the middle of the tube it is narrowed to a breadth of $\frac{5}{8}$ inch; the two front lobes of the border are 3 lines long and broad, the three superior lobes 6 lines long and broad, the laciniated segments 4 lines long, 1 line broad; the stamens are 6–8 lines long; the stigma extends 12–16 lines beyond the mouth. These details are obtained from Plumier's original drawing of the plant, preserved in the British Museum, assisted by the specimens above quoted. The fruit, stated by Plumier to be large and ovate, is shown in that drawing to be $4\frac{1}{2}$ inches long, $3\frac{3}{8}$ inches in diameter, surmounted by an obtuse mammillary projection 4 lines

long, and supported by the solidified disk 8 lines in diameter, upon a peduncle 2 inches long.

Lamarck, in his 'Illustrations,' tab. 547, to show the structure of *Crescentia*, made an incorrect copy of Plumier's drawing of this species, omitting the most remarkable feature, the duplicature of the tube of the corolla; and he copied Burmann's (not Plumier's) very incorrect drawing of the fruit and seeds, which belong to some species of *Eucrescentia*.

13. Crescentia coriacea, nob.: ramulis teretibus, axillis cupuloso-nodosis; foliis elongato-oblongis, imo cuneatis, apice truncato-rotundatis, subito brevissime apiculatis, subcoriaceis, nervis utrinque 12–14 divaricato-patulis intra marginem arcuatim nexis, supra subnitidis, rugulosis, nervis immersis, subtus pallidioribus, glaucis, marginibus valde revolutis, costa nervisque prominentibus, petiolo brevissimo, crasso: flore solitario, axillari aut terminali; corolla campanulata, tubo ad basin breviter latiore, sursum gradatim infundibuliformi, fauce ampliata, obliqua, hinc antice inflata et transversim sursum introflexa, limbo 2-labiato, labio superiore multo majore, indiviso, erecto, crispatim undulato, inferiore brevi, vix lobato, reflexo, margine dentatim inciso; staminibus superioribus exsertis: fructu obovato, subconico, apiculo tenui superato, imo disco indurato suffulto, pericarpio sublignoso, tenuissimo, fragili, fusco, intus pulposo, nervis 4 parietalibus in membranam laminarem adhærentem immersis, pulpa sicca submedullari, seminibus cordiformi-orbicularibus, crassiusculis, majoribus.—In America meridionali et in Antillis: *v. s. in hb. Mus. Brit.* Jamaica (*P. Browne* ?); Venezuela, ad Boca del Tigre (*Moritz* 1953); *in hb. Hook.* Jamaica (*Dr. Alexander Prior*).

This is a species very different from any of the preceding, in the shape of the leaves, their nervation, the structure of the corolla, and the form of the fruit. The branch is terete, 2–3 lines thick, with axils 1–1½ inch apart: the leaves are 6½–9½ inches long, 2¾–3¾ inches broad, on a thick petiole only 3 lines long. The peduncle is 2 inches long. There is some resemblance in the form of the flower to that of *C. cucurbitina*, but with this essential difference, that in the latter the upper lip is shortest, while here it is considerably longer, and *vice versâ* in regard to the lower lip. The calyx, like that in *C. cucurbitina*, is 1½–2 inches long; the tube of the corolla is 2 inches long, the upper lip 1 inch long, the lower incised lip ¼ inch broad; the transverse duplicature, 3 lines below the mouth on the ventral side, gives it a ringent appearance, as in *C. obovata*. The fruit is 3½ inches long, 2 inches in diameter, somewhat tapering upwards above the middle; the pericarp is only one-third the thickness of that in *C. cucurbitina*, is very brittle, with an external rugose surface, subpolished, dark, and is lined internally with a pale brown, laminated, membranaceous coating, in which the 4 placentary nervures are imbedded. The seeds are large, thick, and quite like those figured by Gaertner; the pulp which encloses them has a very different texture from that found in the preceding section, being of an almost pithy consistence, which does not grow black, and remains somewhat viscous in drying: the seeds are of a darkish colour, suborbicular, deeply emarginated at top and bottom, somewhat compressed, with a deep groove along each face, in one of which is seen the line of the raphe terminating in the hilum a little

above the base; the outer integument closely invests the inner tunic; both are membranaceous; the embryo is black, 6 lines long, 8 lines broad, $3\frac{1}{2}$ lines thick, grooved down each face, with a deep emargination in the summit, and another at the base, formed by 2 short auricular lobes, the short radicle being entirely concealed within these lobes.

14. Crescentia cuspidata, nob.: ramulis obtuse angulatis, substriatis; foliis majusculis, elongato-oblongis, imo cuneatis, apice abrupte acuminatis, supra opacis, scrobiculato-impressis, nervis subimmersis utrinque circiter 16 divaricatis et arcuatim nexis, subtus pallidioribus, nervis paulo prominentibus, nervo marginali prominulo, petiolo crassiusculo, brevissimo: flore solitario, terminali aut axillari, longe pedunculato; calyce subcylindrico, longo, fere ad basin bifisso, extus varioloso-punctato; corolla infundibuliformi-campanulata, extus scabrido-punctulata, tubo striato-nervoso, calyce paulo longiore, ad faciem ventralem infra faucem subito transversim introflexo, limbo sub-2-labiato, labio superiore longiore, latissimo, crenulatim eroso, labio inferiore breviter 3-lobo, lobis rotundatis, suberectis, inæqualiter inciso-dentatis; antheris vix exsertis; stylo longe protenso: fructu ovato, apice obtuse apiculato vel umbonato, pericarpio duro, crassiusculo, extus impresso-punctato, intus pulposo, seminibus majusculis.—In Venezuela et Antillis: *v. s. in hb. Hook.* Tovar (*Fendler*, 780); Tope prope Caraccas, unde "Coco de Mono" dicitur (*Burchell*); S. Vincente (*Guilding*).

This species differs from the preceding, which it much resembles, in the more prolonged shape of its leaves, suddenly contracted at the apex into a cuspidated acumen; the form of the corolla is different; and it has a more oval fruit, having a hard, stout shell with a pallid punctated surface. The leaves are $7\frac{1}{2}$–12 inches long, $2\frac{3}{4}$–4 inches broad, on a rather stout petiole 3–5 lines long: the peduncle is 2 inches long; the calyx is $1\frac{1}{4}$ inch long; the tube of the corolla $1\frac{3}{4}$ inch long, the upper lip 6 lines, the lower lip 3 lines long, the upward sudden introflexion being 3 to 6 lines beneath it. The fruit is 3–$3\frac{1}{2}$ inches long, 2–$2\frac{1}{2}$ inches broad, seated on the persistent disk upon a pedicel $2\frac{1}{4}$ inches long; the pericarp is 1 line or more in thickness, with 4 adnate parietal nervures cruciately disposed; the seed is 7 lines long, 9 lines broad.

15. Crescentia elongata, nob.: ramulis cortice suberoso, rugoso-punctato, rimoso, nodis cupuloso-nodosis; foliis oblongo-lanceolatis, imo breviter subcuneatis, apice repente attenuatis, lateribus fere rectis et parallelis, coriaceis, supra opace viridibus, nervis utrinque circiter 12 immersis, subtus concoloribus, nervis prominulis, petiolo brevi, crassiusculo: floribus solitariis, longe pedunculatis; calyce magno, oblongo, hinc ad medium fisso, illinc breviter 3-fisso; corolla infundibuliformi-campanulata, tubo incurvato, impunctato, fauce aperta, regulari, limbo sub-2-labiato, labio superiore erecto, sub-2-lobo, inferiore subdeclinato, breviter 3-lobo, lobis margine sinuato-crenatis: fructu ovali, pericarpio tenui, testaceo, intus nervis 4 cruciatim parietalibus, quorum 2 oppositis utrinque placentiferis et late expansis, prolationibus in sicco submembranaceis, seminiferis, a pericarpio liberis, seminibus in illas immersis.—In Antillis: *v. s. in hb. Hook.* Monte Verde, Cuba orientali (*Wright*, 361 bis).

This species is distinct from any of the foregoing in the form and structure of its fruit, in its leaves, which are somewhat smaller and narrower, with more distant nerves than those of the preceding species; and the flower is also different. The leaves are $4\frac{3}{8}$–8 inches long (including the rather stout petiole of 3 lines), and $1\frac{3}{4}$–$2\frac{3}{4}$ inches broad: the peduncle is $1\frac{1}{2}$ inch long, and somewhat slender; the calyx is $1\frac{3}{4}$ inch long, 7 lines in diameter; the tube of the corolla is $1\frac{3}{4}$ inch long, the open oblique mouth nearly an inch in diameter; the upper lip is erect, $\frac{1}{2}$ inch long; the lower, somewhat deflected lip is $\frac{3}{4}$ inch long. A longitudinal section and moiety of the fruit, evidently not mature, is glued upon the same sheet as the plant: it is $2\frac{1}{2}$ inches long, 2 inches broad, and regularly oval; the pericarp is thin and testaceous, with 4 equidistant longitudinal nerves imbedded inside: in the moiety exhibited, the 2 lateral nerves are barren, the intermediate one, 1 line broad, emits on each side a broad thickened membranaceous plate, quite free from the rest of the shell, in which the immature seeds are imbedded. This feature alone gives a very distinctive character to the species.

DESCRIPTION OF THE PLATES.

Plate VII.

Fig. 1. *Crescentia plectantha*: a fascicle of its leaves seated in a warty excrescence formed of imbricated ligneous scales upon the older branches.

Fig. 2. A flower of the same in bud, when the solidly closed fleshy calyx only is seen, before it becomes ruptured by the expansion of the enclosed corolla.

Fig. 3. The same after the bursting of the calyx, showing the corolla corrugately plicated, with the lobes of its border wholly inflected, in the manner of its peculiar mode of æstivation.

Fig. 4. The corolla after its complete expansion, removed from the calyx, showing the downward deep plicature of the tube upon the ventral side.

Fig. 5. The same cut open, to exhibit the position of the stamens in regard to the plicature of the tube.

Fig. 6. The calyx, from which the corolla has been removed, showing, at the period of the full expansion of the flower, the ovary seated in the fleshy disk and surmounted by the style and stigma.

Fig. 7. The ovary after the fall of the flower, and then more fully grown, the segments of the calyx having just fallen off; it is seated within the polished fleshy disk, and is punctated all over with numerous small concave dots, and is besides marked by a few distant glands seen in the bottom of large excavations.

Fig. 8. A vertical section of the same, showing two of the longitudinal parietal placentæ covered with very numerous, crowded, black, shining ovules.

Fig. 9. A transverse section of the same, exhibiting the position of the four longitudinal parietal placentations in its 1-locular cell; upon the surface of the prominent fleshy placentæ are seen the salient points upon which the ovules are attached in a crowded state. *All of the natural size.*

Fig. 10. An ovule, *highly magnified.*

Fig. 11. A longitudinal section of the ripe fruit, from which half of the pericarp and the whole of the seminiferous pulpy mass have been removed: there are now seen remaining the many ligneous cords or nervures which spring from the base of the cell, at which point they are somewhat imbricated; but they immediately divaricate, rising upwards free from, but close to

the pericarp, and, becoming thinner, terminate in threads near the summit; those cords are charged with numerous branching fibres and nourishing-vessels, imbedded in the numerous laminar membranes which radiate from them in all directions, and which, becoming fleshy and agglutinated together, form the solid pulpy mass enclosing the seeds, and filling the entire capacity of the cell of the fruit. *Of the natural size.*

Fig. 12. A seed, *also of the natural size.*

Fig. 13. The same, *magnified* and seen in face, the hilum being the minute point in its base.

Fig. 14. The same, seen on its edge.

Fig. 15. The same, with half of the outer integument removed, showing the position of the chalaza, in the summit of the inner integument, with respect to the hilum.

Fig. 16. The inner integument freed from its covering and marked by the chalaza in the sinus of the summit, while the base is prolonged into a narrow thread terminating in the hilum.

Fig. 17. The inner integument has been removed to show the embryo which it enclosed; it is seen in front.

Fig. 18. The same, seen sidewise.

Fig. 19. The same, with one of the cotyledons removed, showing the size and relative position of the radicle.

Fig. 20. The cotyledon which has been removed,—*all being magnified on the same scale.*

Plate VIII.

Fig. 1. A portion of a branch of *Crescentia fasciculata.*

Fig. 2. A flower of the same, expanded.

Fig. 3. A portion of a branch of *Crescentia linearifolia.*

Fig. 4. An entire fruit of *Crescentia linearifolia.*

Fig. 5. A vertical section of the same, with half of the pericarp and the pulpy mass removed, showing four parietal nervures imbedded in the laminar membranes which are agglutinated to the inner surface of the pericarp. *All of the natural size.*

Plate IX.

Fig. 1. A portion of a branch of *Crescentia* (*Enallagma*) *coriacea,* with two ripe fruits attached.

Fig. 2. The calyx, from which the flower has fallen off.

Fig. 3. The corolla removed, as seen in a dried specimen, in which is seen the short upward duplicature of the tube on the ventral side, forming a ringent swelling within the mouth: the upper lip is entire, with a crispate margin; the lower lip has the margin cut into acute laciniated teeth.

Fig. 4. The ovary, some time after the fall of the flower.

Fig. 5. A transverse section of one of the fruits, showing its thin brittle pericarp and contained seeds.

Fig. 6. A seed from the dried specimen, covered by a pith-like substance, or exsiccated portion of the pulp.

Fig. 7. The same, seen edgewise.

Fig. 8. A seed with the covering removed, deeply grooved on the two opposite faces, showing the membranaceous testa marked by a cord-like raphe terminating in a somewhat lateral hilum.

Fig. 9. The embryo, from which the two integuments have been removed; in the basal sinus are seen the two small auricular lobes on each cotyledon, beneath which the very short radicle lies concealed.

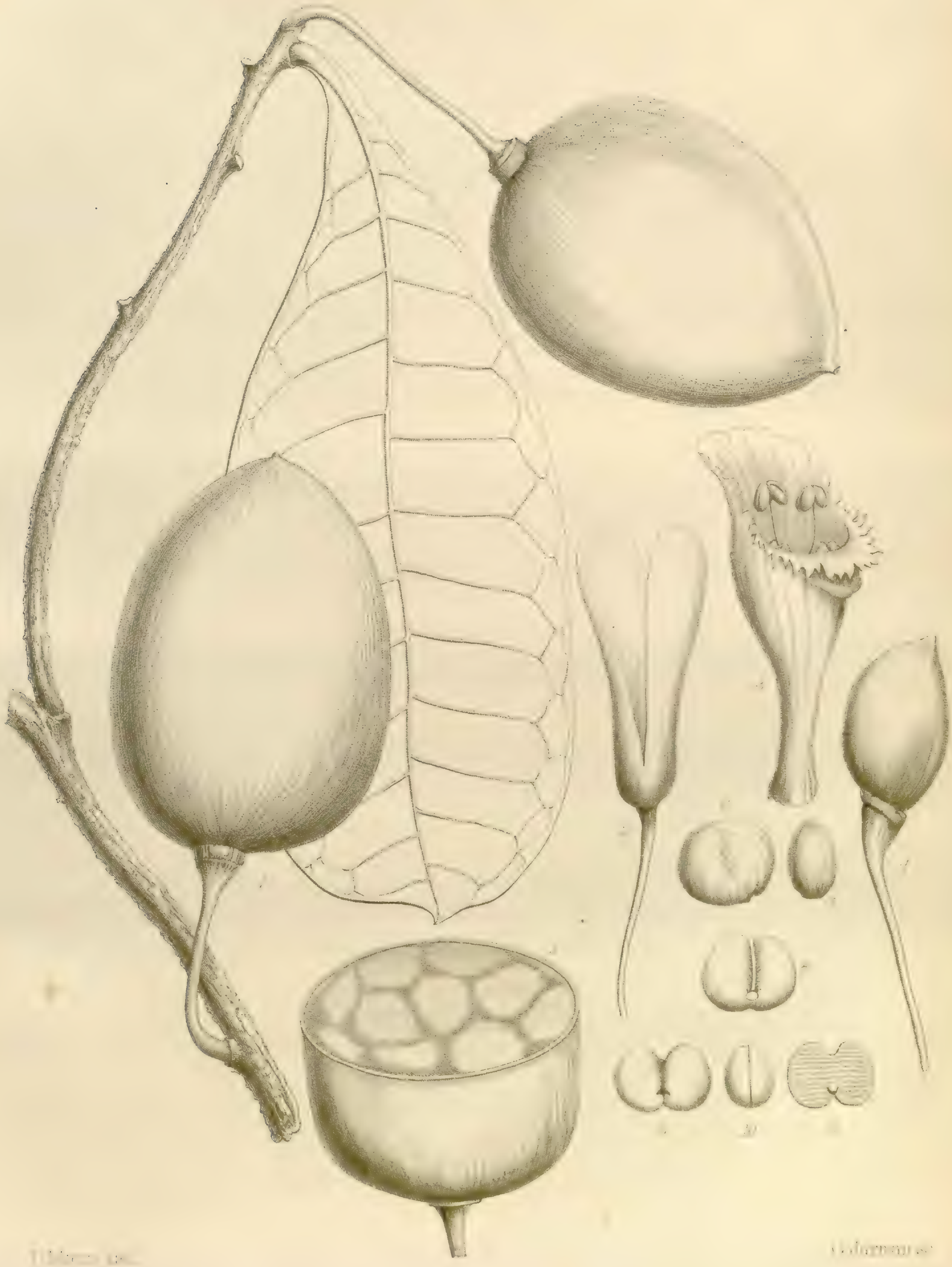
Fig. 10. The same, seen on the edge, to show the thickness of the cotyledons.

Fig. 11. A cotyledon seen from its inside flat surface, showing the size and position of the concealed radicle. *All of the natural size.*

J. Miers del

J. Harrison sc

C. Jarman sc.



III. *On* Pauropus, *a New Type of* Centipede.

By Sir John Lubbock, *Bart., F.R.S., V.P. Linn. Soc., Pres. Ent. Soc., V.P. Ethn. Soc., &c.*

(Plate X.)

Read December 6th, 1866.

The little creature which I am about to describe in the present Memoir was found by me during the course of the last autumn, and exhibited to the Entomological Society at their first meeting in these rooms.

It occurs in considerable numbers among dead leaves, and in other accumulations of decaying organic substances, in company with the various species of Thysanura, mites, worms, &c. which frequent similar situations. Though not exactly sociable in their habits, and though I never saw them take any notice of one another, still they exhibit none of that extreme ferocity which characterizes the Chilopoda, and do not appear to avoid one another's presence. It may, however, have been owing to their frequency that I have often found many of them together.

In my garden, indeed, they are very common; and it is surprising that they should have been overlooked so long. Of course it is quite possible that their abundance with me this autumn may have been merely a local and temporary accident; they may be rare as a rule, and thus have escaped until now the notice of the naturalist. On the whole, however, I feel rather disposed to think that, from their minute size, their small number of legs, and general appearance, they have been looked on as larval forms. This would probably be the first impression of any naturalist; at any rate it was my own; but it is clearly untenable. In the first place, we have no group of Centipedes in this country to which *Pauropus* could be referred. The young stages of most genera belonging to the Diplopods are well known, and very different from my little creature. We might say almost the same of the Chilopods, from which, moreover, it differs in the structure of the mouth, as well as in the arrangement of the legs. Secondly, I have had many hundreds of specimens under examination, and am well acquainted with the earlier forms, which I shall presently describe. I have even one specimen which has lived in confinement from the 18th of August*; and yet I have never had any which exceeded, either in size or in the number of legs, those now to be described. Thirdly, I have on several occasions met with specimens containing numbers of spermatozoa (Pl. X. fig. 16), and which, therefore, may be regarded as mature males.

However much, therefore, we may be surprised at the existence of so small a Myriapod, there can, I think, be no doubt on the subject. There are other points in which the present form differs greatly, as will be seen from the following description, from all

* This specimen lived until the middle of December. It was lively and apparently in perfect health until within a few days of its death.

other known Centipedes, among which it must certainly constitute a new family, Pauropodidæ, and, I think, even a new order, which might perhaps be called Pauropoda.

I will now proceed to describe this curious form.

PAUROPUS HUXLEYI, n. sp. Corpus e segmentis decem, setis sparsis. Pedum paria 9. Antennæ 5-articulatæ, bifidæ, appendicibus tribus, longis, multiarticulatis.

Body composed of ten segments, including the head; convex, with scattered hairs. Nine pairs of legs. Antennæ five-jointed, bifid at the extremity, and bearing three long, jointed appendages.

The body consists of ten segments, the first two of which compose the head. In form it is slightly conical, each of the first eight segments being somewhat broader as well as longer than that which precedes it. The two caudal segments, again, are somewhat smaller than the antepenultimate. There are only nine pairs of legs, and their distribution is peculiar. The third segment, or that immediately following the head, bears one pair, while the fourth, fifth, sixth, and seventh segments have two pairs each. These segments, however, may be regarded as double. The posterior legs are the longest. Each segment, from the third to the seventh inclusive, has on the side margins of the back a pair of strong bristles. The pair attached to the third segment (Plate X. fig. 1) point forwards, those of the fourth are at right angles to the body, and the posterior ones point backwards. Besides these long bristles, the body bears on each of the larger segments two transverse rows of short, stiff, club-shaped hairs, which are most numerous on the head.

The body is quite white and colourless, but towards the head and tail it has sometimes a slight tinge of yellow.

Length $\frac{1}{20}$ of an inch.

Pauropus Huxleyi is a bustling, active, neat, and cleanly little creature. It has, too, a look of cheerful intelligence, which forms a great contrast to the dull stupidity of the Diplopods, or the melancholy ferocity of most Chilopods.

It lives throughout the year, among dead leaves and other decaying vegetable matter. It is active in its habits, continually running about, and sometimes giving a rush of surprising velocity. Throughout the winter I found it on the warmer days. It often cleans its feet and antennæ with its mouth. In the latter case the antennæ are held to the mouth by the front legs, a habit which may possibly be an indication that this pair of legs is homologous with the jaw-feet of Chilopods *. The head is composed of two segments, which have received the names of cephalic and basilar (See Newport, Linn. Trans. vol. xix.). Seen from below they are nearly equal in size; but from above the posterior edge only of the basilar segment is visible, the rest being covered by the cephalic. In the same manner, when seen from below, the separate segments to which the legs are attached are plainly visible; the last segment also is evidently treble. Thus there are indications of fourteen segments.

On the upperside of the head are two oval figures, which I presume to be eyes (Plate X. fig. 3). They are, however, very unlike those of other Centipedes, and show no trace whatever of facets. On the head are a number of short, club-shaped, ringed hairs.

* In *Lithobius*, however, these are attached to the basilar segment of the head.

The antennæ (Plate X. fig. 7) are 5-jointed, and bifid at the extremity. The four basal segments are simple and short, but increase slightly in length from the base. The fourth segment bears at its extremity two branches, each consisting of a single segment. One is slightly longer than the fourth segment, and rather thinner (*a*). The other (*b*) is nearly twice as long, and half as broad; it bears at its extremity a very curious appendage, consisting of an immense number of rings, the first and last of which are larger than the others. The first branch (*a*) terminates in two similar but somewhat shorter appendages. These curious appendages remind one very much of the toy-snakes, which consist of a number of saucer-like appendages united by their middles. Between them lies a small pear-shaped appendage (*c*). The fourth segment of the antennæ bears also three hairs at its extremity, two on one side and one on the other. The latter is much shorter than the other two. Each of the three basal segments supports a pair of rod-like, almost clubbed hairs, which are divided by a number of lines, almost like the curious ringed appendages. These ringed hairs are no doubt connected with sensation. Between the two appendages of the branch *a* is a small rounded body.

The animal, as already remarked, often cleans the terminal portion of the antennæ with its mouth. In the structure of the mouth *Pauropus* appears not exactly to agree either with the Chilopods or the Diplopods. I found two pairs of organs: the mandibles (Plate X. fig. 4) are somewhat elongated, and have several teeth at the extremity; the other pair of appendages (Plate X. fig. 5) are minute and conical.

The legs are eighteen in number, twenty-two being the smallest number in any previously known Myriapod. They are simple, and increase in size from in front backwards, the last pair being about twice as long as the first. The anterior legs (Plate X. fig. 10) are $\frac{1}{125}$ of an inch in length, and consist of five segments, which, according to analogy with other Myriapods, we may regard as coxa, femur, tibia, and two-jointed tarsus. The coxa is short, and has on its underside a curious, triangular, leaf-like appendage. The femur is rather longer, and bears on its underside a somewhat similar leaf-shaped appendage. The tibia is shorter than the femur, and about as broad as it is long. The first segment of the tarsus is about as long, but thinner than the femur; it bears a stiff spine on its anterior margin. The second tarsal segment is still longer, thinner, and slightly tapering. There are indications of a division near the middle.

The structure of the foot is not easy to make out. There seemed to me to be a pad, a claw, and a very short tenent hair.

The second pair of legs (Plate X. fig. 11) are rather longer than the first, which they much resemble, with, however, one remarkable difference—namely, intercalation of a new segment between the first and second tarsal joints. This raises the number of tarsal segments to that usual among Myriapods. The new segment bears a short spine on its anterior side.

The posterior legs (Plate X. fig. 12), which are the longest, are $\frac{1}{65}$ of an inch in length. Curiously enough, they resemble the anterior legs in the number of their segments. They possess, however, the additional seta. The leaf-like hair on the femur is brnched (Plate X. fig. 13).

Between the second pair of legs are two appendages (Plate X. fig. 19), which are

probably the generative organs. They do not appear to be present in all specimens, and belong to the male sex, as in one case I saw them distinctly in a specimen which was full of spermatozoa. In one case I traced two tubes opening into them. On the underside of the anterior segment of the body, in front of the first pair of legs, are two pairs of leaf-like hairs, like those on the coxæ and femora of the legs. These evidently indicate the presence of an anterior aborted pair of legs.

The dorsal hairs are also remarkable. The long ones, of which there are a pair to each segment, are ringed and delicately plumose. The lateral setæ, however, are short and extremely delicate. The short scattered bristles are arranged in rows across the back; except the first two and last two, each segment has two rows of them; there are about six in each row; they are stiff and club-shaped (as shown in Plate X. fig. 6).

At the posterior end of the body (Plate X. fig. 17) are several other stiff spines, and two minute forked processes.

Several specimens contained large numbers of spermatozoa, which are filiform (Plate X. fig. 16) with a small head at one end. I never saw them in motion.

Though the animal is tolerably transparent, and the digestive organs are plainly visible, I never could see any trace of tracheæ. Being so small and delicate a creature, it is probable that the respiration is carried on through the skin: but if this is the case, *Pauropus* presents us with another very important peculiarity,—all other Myriapods, so far as we know, possessing tracheæ.

The smallest specimens which I have met with were about $\frac{1}{72}$ of an inch in length, and possessed three pairs of legs only (Plate X. fig. 18). The first pair was attached to the third segment (*i.e.* the one immediately succeeding the head), the other two to the following one. Beyond the legs were two other segments, making six in all, as seen from above, and counting the head as two. The fourth and fifth segments each bear a pair of long bristles, as in the full-grown form: the first pair point outwards and forwards, the latter outwards and backwards. The general arrangement of the hairs and of the short caudal processes is the same as in the large specimens; and the antennæ are formed on the same plan.

I found the first of these six-legged ones on the 11th of September; but I am not prepared to say that they might not have been met with earlier if they had been looked for. They continued tolerably numerous throughout the autumn, and occurred in the same localities as their parents.

The development of *Pauropus*, at least in captivity and during winter, is far from rapid. A specimen with three pairs of legs, captured on the 24th of October, has not yet undergone any change *. It remains to be seen whether under more favourable circumstances the growth may not be quicker.

* This specimen died on the 6th of December. Another, captured on the 23rd of November, lived for a month without change. A third, caught on the 3rd of November, survived until the 20th of February. A specimen with six pairs of legs, caught on the 20th of October, also lived till the 8th of February, without change. Another, with eight pairs of legs, lived from the 30th of September to the 5th of November, when it met with an accident. I observed also in *Chloëon* that my larvæ remained with scarcely any change during the winter months (see Linn. Trans. vol. xxv.).

I have never met with a specimen possessing four pairs of legs, and am persuaded that none such exist. Indeed in one case I had the opportunity of watching a six-legged specimen in the act of moulting. It was standing over the old skin, in which its legs and antennæ were still entangled. In about an hour it walked off, carrying the old skin attached to one of its posterior legs. There was no great change except the addition of another large segment and two more pairs of legs—making altogether five pairs. Its length was $\frac{1}{64}$ of an inch.

It is curious that two pairs of legs should be acquired at this moult, because in the subequent ones only one new pair are formed. The changes indeed are slow, and as yet I have only succeeded in breeding any up to the stage with six pairs; but as I have met with many specimens possessing respectively seven pairs and eight pairs, we may, I think, safely conclude that a new pair are added at each moult after the first, until the full number are acquired.

PAUROPUS PEDUNCULATUS (Plate X. fig. 20).

I have also met with another species of *Pauropus*. In habits and time of appearance, in form, and size it resembles *P. Huxleyi*, but appears to be much rarer; at least, among several hundred specimens I only observed half a dozen of this form. These appeared to me to be rather yellower in tint; but the difference was very slight, and I am not sure if it was constant.

The principal difference between the two species, and that by which they may be distinguished at a glance, resides in the antennæ (Plate X. fig. 20).

The basal portion, indeed, is alike in both. The apical part, on the contrary, differs considerably. The two processes (*a* and *b*, Plate X. fig. 20) are nearly of equal length. One of the long ringed appendages of *a* is situated at, and occupies the whole of the extremity; it is longer than that in the other form, and nearly as long as the similar appendage of *b*. The other ringed appendage is situated at the side of *a*, and is much shorter, while in the other form the two appendages of *a* are of equal length. The small pear-shaped body between the two appendages is much larger in this than in the other form, and is seated on a stalk.

Colour white with a tinge of yellow.

Length $\frac{1}{25}$ of an inch.

Found in autumn, among dead leaves &c. Not common.

There has been much difference of opinion among naturalists as to the value which ought to be assigned to the group of Myriapods,—Leach, Gervais, Newport, Strauss Durckheim, Busk, and Huxley ranking them as a distinct class; while other eminent naturalists, such as Linnæus, Lamarck, Latreille, Siebold, Cuvier, Owen, Brandt, and others, have regarded them as constituting an order only. Again, there has been great difference of opinion as to their affinities; for while the majority of the last-named naturalists classed them among the true insects, Siebold and Oken placed them among the Crustacea, and Lamarck among the Arachnida, while Latreille regarded them at one time as forming part of the Crustacea, at another as Arachnida, and lastly as insects. To these illustrations many others might have been added; but enough have been cited to

show how greatly the most eminent naturalists have differed in opinion as to the true position of the Myriapods.

Nor can we wonder that it should have been so. In their development the Myriapods resemble Annelids, from which, however, their articulated legs and organs of respiration clearly separate them. With the Crustacea they agree in possessing numerous legs; but, again, they are distinguished from them by the possession of tracheæ. In this character, as well as in their antennæ, they resemble true insects; but the number of legs, as well as the manner in which they are acquired, renders it difficult to regard them as constituting an order in that class. Finally, they agree with the Arachnida in the possession of more than six legs, though their development and antennæ are sufficient to exclude them from that group also.

We must therefore, I think, regard the Myriapoda as forming a class, separated from the other classes of Annulosa by characters of at least equal importance with those by which those classes are distinguished from one another. I say, of at least equal importance, because, while the higher families of the Crustacea and the Arachnida are clearly separated by the nature of their respiratory organs, the lower ones, which have neither evolutions of the external integument forming branchiæ on the one hand, nor involutions on the other, approximate in their characters so much as to render any satisfactory diagnosis very difficult; so that some genera, as for instance the *Pycnogonidæ*, are actually classified by some eminent naturalists among the Crustacea, and by others among the Arachnida.

As regards the Myriapods no such difficulty has ever arisen. There is no species about which there has ever been a doubt whether it belonged to that group or not. The curious form described under the name of *Peripatus* by Guilding, may perhaps, indeed, be cited in opposition to this; but although Gervais* and de Quatrefages† have expressed the opinion that this genus forms an approximation to the Myriapods, the former does not even mention it in his work on the Myriapods (among the "Suites à Buffon"), and the absence of articulated legs is quite sufficient to remove all doubt on the point.

Strauss Durckheim considered that *Polyxenus* would conduct us to the Annelids through *Nereis*, while other naturalists have regarded the Geophilidæ as forming an approximation to the same group, and Glomeridæ to the Isopods, and especially, of course, to the Oniscidæ. With Gervais and Walckenaer I regard all these resemblances as merely analogical and by no means as expressing true affinities, except, indeed, of an extremely remote character.

It is a remarkable fact, that, so far as we at present know, all Myriapods have at first, like the mites, three pairs of legs, and three pairs only. It might at first be supposed that these three pairs represented those of insects, and that other pairs were subsequently added on behind—a process which in the Arachnida was arrested after the production of a single new pair, while in the Myriapoda it was carried on to a variable but much greater extent. Although, however, there has been much difference of opinion as to the homologies of the first three pairs of legs in mites and spiders, there seems to be a

* Ann. des Sci. Nat. 1837.

† Hist. Nat. des Annelés ("Suites à Buffon"), vol. ii. p. 675.

general agreement of opinion that they do not represent the three pairs of legs among insects. Savigny regarded them as abdominal appendages; Leuckart considered them to represent the mandibles and two pairs of maxillæ in insects; Siebold and Zaddach, though differing as to the true nature of the anterior appendages, agreed in regarding the first three pairs of legs in Arachnida as corresponding with the second pair of maxillæ and first two pairs of legs in insects, while Huxley refers them to the two pairs of maxillæ and the first pair of legs. The same opinion has been adopted by Claparède; and it must be admitted that these two eminent observers have brought forward very strong arguments in favour of the view advocated by them. Moreover it must be remembered that the six embryonal legs of Myriapods do not belong to three consecutive segments, as ought to be the case if they represented the three pairs of legs in insects. In *Iulus*, for instance, the three pairs are situated on the second, third, and fifth segments *. This agreement in the number of legs between the insect and the young Centipede has not, then, that significance which we might at first sight be disposed to attach to it.

Nevertheless the fact that Centipedes commence life with no more legs than other Arthropods, and only acquire by degrees their most obvious characteristic, is very important; and as what is true of all the species may be reasonably concluded to have been true of the whole group, we might have inferred *à priori* that, although, in the words of Newport, "there are never fewer than twelve segments and eleven pairs of legs in any genus of Myriapoda"†, still there must have been at one time species possessing a smaller number of appendages.

The genus *Pauropus*, which I am now describing, is in fact such a form, and possesses only nine pairs of legs, which is less by two pairs than any form previously known, and tends therefore to a considerable extent to fill up the gap. The paucity of legs, however, is only one of the very interesting peculiarities which it presents.

In fact the mere possession of a small number of legs need not by itself indicate such a link; for we might reasonably expect to find this character, not only among the transitional forms which must lead up to the typical Myriapod, but also at the other end of the series, among the more highly organized and fully developed members of the group. Such I take to be the case with the Scutigeridæ and Lithobiidæ, which, among all the hitherto known species, possess the smallest number of legs. "The form of the head," says Newport, "of the Scutigeridæ, the long setaceous antennæ, the prehensile forcipated mandibles, the elongated palpi, the projecting compound organs of vision, the elongation of the limbs, and the more compact form of body are all indications of a higher degree of organization in this family than in others of the same class, and place it as much above the other genera of Myriapoda as the most complete organization of the predaceous *Cicindela* places that genus at the head of true insects" ‡. If *Scutiger* represents *Cicindela*, *Lithobius* may be regarded as holding the same relation to *Carabus*; and in the one as in the other the small number of legs must be regarded as a result of adaptation, and not as an indication of affinity; they are the highest and most developed forms of the

* In *Polydesmus*, on the contrary, they are on the second, *fourth*, and fifth segments. The second pair of legs, apparently, therefore, belong to different segments in the two genera.

† Trans. Linn. Soc. vol. xix. p. 269.

‡ *L. c.* p. 349.

Chilopoda, and occupy a position further removed from other Articulata even than those species in which the legs are more numerous.

It must be admitted that in some important characteristics *Pauropus* closely resembles *Scutiger* and *Lithobius*; the structure of the legs and the mandibles show, however, I think, that these resemblances are analogical only, and do not indicate any close affinity. In fact the Scutigeridæ are, as we have seen, highly developed Chilopoda, which is by no means the case with *Pauropus*. If, however, the Myriapods are descended from ancestors having a smaller number of segments and of legs, then we must expect to find that the links by which we shall eventually be able to connect not only the two great orders of Centipedes together, but also the Myriapods as a whole with the other classes of Articulata, will possess a small number of appendages. The Scutigeridæ, as we have seen, do not constitute such a group; *Pauropus*, I think, does.

Here perhaps it may be as well that I should quote the distinctive peculiarities which characterize the two known orders of Myriapoda *, the Chilopods and Diplopods; of which the first are active and carnivorous, the second, on the contrary, sluggish vegetarians.

Chilopods. Antennæ 14-jointed at least. One pair of legs modified into powerful jaw-feet. Generative organs opening at the posterior extremity of the body. Legs in single pairs.

Diplopods. Antennæ with not more than seven segments. No jaw-feet. Apertures of the generative organs in the anterior part of the body. Legs, after the first six, arranged in double pairs.

Pauropus is, as already mentioned, a neat, active little creature, and at first sight certainly looks like a Chilopod: indeed the compactness of the body, the dorsal plates, and the elongation of the posterior legs give it much resemblance to a small *Lithobius*. A closer examination, however, at once shows that it differs in very important points from the Chilopods: the antennæ possess only five segments, the powerful jaw-feet are absent, and I believe that the openings of the generative organs are situated in the anterior part of the body.

Nor will my new genus find a more natural place among the Diplopods. It is true that the eight posterior legs correspond to four dorsal segments; nevertheless it is evident that in reality each pair belongs to a separate segment, as may clearly be seen if we look at the animal from the underside, as in Plate X. fig. 2. It may be said that, in one sense, this is true of the Diplopods; but they always have the pairs of legs attached by twos, which is not the case in *Pauropus*, where, as will be seen by the figure, they are equidistant. Moreover in all Diplopods the first three pairs of legs are distinguished from the rest by being each attached to a single apparent segment, whereas in *Pauropus* this is only the case with the first pair. Again, in the Diplopods the legs are equal in size, or, if there is a difference, the posterior pairs are rather smaller than the others, while in the present genus they are decidedly larger. In all Diplopods, again, the feet

* I omit for the present the suctorial Myriapods, which require further study.

terminate in simple claws, which, as we have seen, is not the case in this genus. The mouth-parts in *Pauropus*, though very different from those of the Chilopods, appear to resemble those of that group in a rudimentary condition, rather than those of the Diplopods. Lastly, the eyes and antennæ are very unlike those of the Diplopods.

This little genus, therefore, does not possess the characteristics of either order of Myriapods, but forms a link not only connecting the Chilopods and Diplopods together, but also bridging over to a certain extent the great chasm which separates them from other Articulata. It must at any rate be regarded as a new family, even if it does not constitute the type of a third order among the Myriapods.

Pauropus, moreover, possesses several other peculiarities, which are of the more interest because the Myriapods hitherto known present a homogeneity in their characters which is very remarkable if we consider the value of the group, their extensive geographical range, and the number of species. In its general appearance, in its minute size, in the character of its antennæ, in the possession of clubbed hairs and long setæ, *Pauropus*, on the contrary, does something to relieve the disagreeable monotony of the class.

The antennæ are particularly remarkable, and the more so because, in all known Myriapods, these organs are simply filiform, and short, almost invariably seven-jointed among the Diplopods, longer and possessing more numerous segments among the Chilopods. The antennæ of *Pauropus*, on the contrary, in their bifid character, and in the possession of long, jointed appendages, offer peculiarities which can be found, so far as I am aware, among no other terrestrial Articulata, and which remind us strongly of the types presented by the antennæ of certain Crustacea.

I exhibited and named this little creature at a recent meeting of the Entomological Society. On that occasion Mr. Westwood remarked that, with the exception of the genus *Iapyx*, described by Mr. Halliday, *Pauropus* was the most interesting addition to the Articulata which had been made for many years. I may perhaps attribute too much value to it; but, considering the importance of the groups which it serves to connect, and the numerous as well as important points in which it differs from all hitherto known species, I cannot help thinking that even the genus *Iapyx*, interesting as it undoubtedly is, presents fewer peculiarities and is less instructive than the little creature which I have now had the pleasure of describing.

Note.—As I have already observed, one of the specimens which I captured early in August, lived until the middle of December. Until within a few days of its death, it was lively and apparently in good health and spirits; but it did not increase in size, or undergo any change. Throughout the winter I have found other specimens in their usual haunts. Like the Thysanura &c., they retire into the most sheltered places, and are difficult to find in very severe weather, but reappear again on the return of a milder temperature. I have carefully watched them during the spring, and have kept several specimens in captivity, but have seen nothing which would lead me to suppose that they undergo any further development. As I have therefore had them under observation for very nearly a year, I think we may safely conclude that it is not a mere immature form, but is really a new type of Myriapod.—July 22, 1867.

DESCRIPTION OF THE PLATE.

Plate X.

Fig. 1. *Pauropus Huxleyi.* Seen from above, × 70.
Fig. 2. „ „ Seen from below, × 70.
Fig. 3. „ „ Outline of head, × 125.
Fig. 4. } „ „ Mouth-parts, × 250.
Fig. 5. }
Fig. 6. „ „ Hair on head, × 250.
Fig. 7. „ „ Antenna, × 250.
Fig. 8. „ „ Base of appendage.
Fig. 9. „ „ Portions of appendage.
Fig. 10. „ „ Anterior leg, × 250.
Fig. 11. „ „ Second leg, × 250.
Fig. 12. „ „ Posterior leg, × 125.
Fig. 13. „ „ Appendage on underside of posterior leg.
Fig. 14. „ „ Appendage on underside of antepultimate leg.
Fig. 15. „ „ Appendage at the base of second pair of legs, × 250.
Fig. 16. „ „ Spermatozoa.
Fig. 17. „ „ Posterior segment seen from above, × 250.
Fig. 18. „ „ Young.
Fig. 19. „ „ Base of second pair of legs, × 125.
Fig. 20. *P. pedunculatus.* Termination of antenna, × 250.

J. Lubbock del

G. Jarman sc.

IV. *On the Lingual Dentition of some West-Indian Gasteropoda.*

By R. J. Lechmere Guppy, *Esq.*, *F.G.S.*, *and* Jabez Hogg, *Esq.*, *F.L.S.*, *M.R.C.S.L. &c.*

(Plate XI.)

Read June 21st, 1866.

Since the investigations of Lovén into the lingual dentition of the glossophorous Mollusca, various observers have studied the subject, with great advantage to our knowledge of the affinities of those animals. Thus we find, amongst other changes, that it has been necessary to remove the Proserpinadæ from the neighbourhood of the Cyclophoridæ, to which they were formerly supposed to be nearly related, and to place them in a more natural position near the Neritidæ. That these investigations are of great value is also shown by the light which has been shed on the true position of *Aporrhais*, supposed by so great a naturalist as Professor Forbes to be akin to the Cerithiidæ, but which is shown by its dentition to belong to the Strombidæ. When once we have thus ascertained the natural position of a genus whose relations are otherwise somewhat doubtful, it is surprising how the characters of the shell, perhaps misunderstood before, concur to bear out the affinities indicated by the teeth. Thus the young *Aporrhais* resembles a young *Strombus* or *Rostellaria*; and *Ceres* and *Proserpina* have evidently characters which approach them to *Nerita*. Observations on *Helicina*, published in 1864, by one of the authors, showed the relationship of that genus to *Nerita*, to which indeed in its dentition it bears a stronger resemblance than does even *Ceres*. These views have been confirmed, independently, by several authors.

It is our object, in the present paper, to make known some new forms of lingual dentition, some of which, it will be observed, point the way to further reforms in our classification of the Gasteropoda *.

* Dr. J. Gray, F.R.S. ('Annals of Natural History,' ser. 2, vol. x. p. 413), writes:—"One result of the study of these papers (Lovén's "On the Tongues of Mollusca") and the examination of the tongues of several mollusks has been to establish more firmly the theory which I have long entertained, that no species of gasteropodous molluscous animal can be properly placed in the system unless we are enabled to examine the animal, the shell, the operculum, and the structure of its tongue; and as none of these parts but the shell can be examined in the fossil species, their position in the various genera must be always attended with more or less uncertainty."

Professor Huxley very properly objects to the use of the commonly-accepted term *tongue* for the tooth-bearing membrane of the mollusca, and he appropriately designates it "the odontophore."

"The *odontophore* consists essentially of a cartilaginous strap, which bears a long series of transversely-disposed teeth. The ends of the strap are connected with muscles attached to the upper and lower surface of the hinder extremities of the cartilaginous cushion; and these muscles, by their alternate contractions, cause the toothed strap to work, backwards and forwards, over the end of the pulley formed by its anterior end. The strap consequently acts after the fashion of a chain-saw (*rather of a rasp*?) upon any substance to which it is applied; and the resulting wear and tear of its anterior teeth are made good by the incessant development of new teeth in the secreting sac in which the hinder end of the strap is lodged. Besides the chainsaw-like motion of the strap, the odontophore may be capable of a licking or scraping action as a whole."—*Huxley's Elements of Comparative Anatomy*, p. 36.

We shall first premise that the teeth on the dental band of the Mollusca are mostly disposed in longitudinal series. In the Pulmonata there is usually a single median row, the laterals on each side being broad and similar. But in most of the other groups the teeth are arranged in three, five, or seven dissimilar series. Taking *Nerita* or *Helicina* as a type, we designate as *laterals* the broad teeth on each side of the median row, the numerous small teeth on the outside of the band being known as *pleuræ*; and the teeth on this are termed *uncini*. The latter are found only in certain groups. Most of the Mollusca mentioned in this paper have been recently described or enumerated in the 'Annals and Magazine of Natural History'*, where further particulars as to their habits and organization will be found.

In the genus *Bulimus* we have a dentition resembling in general characters that of *Helix*—that is to say, a broad dental band with numerous similar teeth. But the forms of the teeth themselves are very varied; and it is a subject for inquiry how far the divisions proposed by zoologists are borne out by this part of the organization. In *Bulimus oblongus* the teeth are subquadrate, with simple obtuse cusps, the laterals differing but slightly in shape and size from the medians. This species is interesting on account of the peculiar frontal appendages, first described by D'Orbigny, which recall to our minds those of the *Nautilus*, though the resemblance is not perhaps great; still it is a morphological resemblance. We find, too, that this mollusk has mandibles somewhat resembling those of a Cephalopod.

The teeth of *Bulimus zebra* have considerable resemblance to the preceding. The animal has no peculiar frontal appendages, like those of *B. oblongus*; and its mandible is not different from those of other members of the group.

Bulimus virgulatus, a mollusk of the Antilles, presents a different type. The teeth are in divergent rows, the medians small, with a round reflexed tricuspid point, the laterals, on subquadrate bases, with denticulate reflexed edges, the cusp on the inner side being rather long. The denticles appear to be 3–4 in number, of which two only are usually seen at one view with the microscope.

The teeth of *Bulimus multifasciatus* (Plate XI. fig. 1), *B. immaculatus*, and *B. aureolus* are so nearly alike, that one description will serve for them all. In general arrangement they are like the preceding species'; but the medians are minute, and the laterals are armed with three long acute cusps, which frequently escape observation, being as pellucid as glass. We have ourselves overlooked them; and owing to this the teeth of this species have on former occasions been wrongly described.

In *Bulimus caracasensis* the medians, so extremely difficult to make out from their minuteness, are simple, the laterals symmetrical; that is, they are equal-sided, differing in this respect from those of most other mollusks. We have observed that several of the species classed under *Bulimus* present this form of teeth, which is also found in *Stenogyra octona* (fig. 2). In *Tornatellina lamellata* (fig. 5) the dentition somewhat resembles that of *Bulimus multifasciatus*, the laterals having long acute pellucid cusps.

In *Plecocheilus auris-sciuri* (fig. 4), a species very near *P. glaber*, the median row is

* Ser. 3, vol. xiv. p. 243, and vol. xvii. p. 42.

remarkable for the great length of the imbricating pellucid cusps. The laterals seem also to have a similar cusp; but it appears to be more often absent than present: as, however, their extreme fragility renders them very likely to be broken off, it is in all probability due to this cause that they are so often found wanting.

Macroceramus signatus (fig. 7) resembles *Helix* more than any of the *Bulimi* here described in its dentition. The medians are elongate, with a single obtuse rounded cusp; the laterals have two round subequal cusps, of which the inner one is situate on the side of the tooth.

Pupa striatella, a species inhabiting Porto Rico and other West-Indian islands, has a dentition somewhat resembling that of *Bulimus*. The teeth are obtusely tricuspid, the medians not any smaller than the laterals. *Succinea approximans* has teeth possessing characters of *Bulimus*, but differing in details, as will be seen by the specimens. In *Veronicella* (*Vaginulus*) *Sloanei* the medians are small, and the laterals as well as the medians are tricuspid. This dentition does not resemble that of *Oncidium*, with which the genus has hitherto been associated.

In *Physa rivalis* the teeth are slender, and bear no great resemblance to those of any of the terrestrial forms. In *Planorbis terversanus* the median teeth are largest, and have three acute points, of which the middle one is the smallest. The laterals have three acute points, of which the outer one is largest. The edges of the teeth are not reflexed. Amongst the marine mollusca which have teeth somewhat of this shape are *Voluta* and *Marginella*; but these have very much fewer teeth, with usually more numerous denticles.

Marginella cærulescens (fig. 3) has a small subquadrate band of acute pellucid teeth, the medians of which are shortest; the laterals are alternately long and short, set on a delicate homogeneous basement membrane.

Streptaxis deformis (fig. 6) has aculeate teeth, resembling those on the lateral portion of the dental membrane of *Zonites cellarius*. The young shell is like a *Zonites*; so that we may readily infer the close affinity of these genera.

The dental apparatus of *Cylindrella trinitaria* (fig. 12) is a singular modification of the inoperculate type. The band is very long, resembling in this respect that of *Littorina*. The individual teeth have a certain likeness to those of *Helix*, but they also recall to our minds, in their mode of arrangement, the Operculata.

The Inoperculata seem hardly to furnish us with much evidence as to their alliances with truly marine genera; but the operculate land-shells, on the contrary, exhibit unmistakeable affinities with several groups. As we have previously remarked, *Helicina* shows relations with *Nerita*: a comparison of them with *N. microstoma* (fig. 9) will prove the fact. A study of the lingual teeth has further made obvious what we might have expected from other characters, that the Cyclostomatidæ must be separated altogether from the Cyclophoridæ. The latter have teeth resembling those of *Littorina*. As examples we may cite *Cyclotus translucidus* (fig. 11) and *C. rugatus*. This dentition is represented by the formula 3 . 1 . 3. The animals of the Cyclostomatidæ, on the other hand, have a foot divided into two longitudinal portions by a groove. As examples of their dentition (00 . 2 . 1 . 2 . 00) figures are given of *Cistula pupi-*

formis (fig. 8) and *Adamsiella aripensis* (fig. 10). It would seem from this that the Cyclostomatidæ are probably not very closely related to the Littorinidæ. Their lingual teeth seem rather to point out an alliance with the Trochidæ, or one of the groups possessing *pleuræ*. But without attempting at present to decide this question, which can only be determined by the examination of several species, we may remark that the Cyclostomatidæ will probably be found a natural and defined group, perhaps entitled to the rank of a suborder, and not very closely related to any existing marine forms.

The relations of the freshwater Operculata are as varied as are those of the land. *Ampullaria* doubtless finds its nearest marine relative in *Natica*,—an opinion which seems confirmed by the form of the shell. The dentition of *Ampullaria urceus* and that of *A. effusa* (fig. 13) are very much alike, and *Marisa cornu-arietis* (fig. 14) does not differ very greatly; the mandible is also similar, showing that the claims of the latter to generic rank must be sought rather in the shape of the shell and the differences of the siphons than in the teeth. *Hydrobia spiralis* appears to be akin to the Melaniidæ; but we should not be surprised if it were found to be as close to *Skenea*.

The horny mandibles of the Mullusca may be deserving of some attention, with a view to the elucidation of their affinities. In *Cyclotus* (*translucidus*) the mandible (fig. 11*a*) is divided into two portions by a median articulation, and it is covered with fine acute denticulations in regular rows*. In most of the Inoperculata the mandible is horseshoe-shaped, and striate or corrugate. In *Ampullaria* the same organ is beak-shaped, like the upper mandible of *Octopus* or *Loligo*.

EXPLANATION OF PLATE XI.

Lingual Dentition of some West-Indian Gasteropoda.

Fig. 1. *Bulimus multifasciatus*, magnified 250 diameters. A wide band, $\frac{1}{8}$ of an inch in length, consisting of numerous rows of similar teeth; *medians* with a central toothlet, and a smaller point on each side; *laterals* in divergent rows, each with three toothlets, and an oblique, broadly reflexed cutting-edge. Mandible semicircular and corrugated.

Fig. 1*a*. Side view of central cusps.

Fig. 2. *Stenogyra octona*, magnified 300 diameters. A narrow band, $\frac{1}{25}$ of an inch in length; *medians* simple, minute, inconspicuous, central cusps longest; *laterals* tricuspid, with central cusp much prolonged. The ova of this species are subspherical, with a white testaceous envelope, sometimes remaining in the shell, whose aperture is thereby nearly filled up; they hatch after the death of the parent.

Fig. 3. *Marginella cærulescens*, magnified 300 diameters. A band $\frac{1}{6}$ of an inch long, of very pellucid, acute pyramidal teeth; *medians* shorter than laterals; *laterals* alternately a long and a short, set on the same plane; basement membrane homogeneous, very pellucid.

* Like *Aptychus*, but more horseshoe-shaped; it is more probable that these problematical fossils are the mandibles of Cephalopoda than the plates of their gizzards. They bear no resemblance in shape to the horny plates of the gizzard of a mollusk.

Fig. 4. *Plecocheilus auris-sciuri*, magnified 100 diameters. A broad ribbon, $\frac{1}{5}$ of an inch long, of subquadrate pellucid teeth; *medians* remarkable for the great length of their imbricated pellucid cusps; *laterals* having bases produced on both sides, and differing from medians in having similar central cusps, on each side of which is a nearly obsolete toothlet; the extreme outer rows modified in form as well as in character.

Fig. 4*a*. Side view of central cusps. Mandible semicircular, with coarse denticulations.

Fig. 5. *Tornatellina lamellata*, magnified 300 diameters. A narrow band, $\frac{1}{12}$ of an inch in length, of numerous pellucid teeth; *medians* small, simple, and inconspicuous, central cusps prolonged; *laterals* large and simple, with long pellucid acute central cusps, and two obsolete dentations on the outer side.

Fig. 5*a*. Side view of central cusps. The mandible is horseshoe-shaped, and composed of a number of pentagonal prisms laid obliquely, resembling the shell-structure of Brachiopoda. This species is viviparous, and during July and August is found full of young animals.

Fig. 6. *Streptaxis deformis*, magnified 150 diameters. Band $\frac{1}{5}$ of an inch long. Formula 10 . 1 . 10. *Medians* simple, aculeate; *laterals* subopaque, irregular, aculeate, enlarged at their insertion into the basement membrane. The animal is of a delicate pink or yellow colour; it is found both on trees and the ground in the forests.

Fig. 7. *Macroceramus signatus*, magnified 150 diameters. A narrow band, $\frac{1}{10}$ of an inch in length, filled with divergent rows of pellucid teeth; *medians* simple, elongated, with simple obtuse cusps; the *laterals* have two reflexed subequal cusps.

Fig. 7*a*. Side view of central cusps.

Fig. 8. *Cistula pupiformis*, magnified 300 diameters. 00 . 2 . 1 . 2 . 00. Lingual band small and delicate; *medians* denticulate, with acute cusps, outer cusps prolonged; 1*st laterals* broad at bases, with prolonged central cusps, and with subdued denticulations on either side; 2*nd laterals* broad, recurved, cusps well developed; *uncini* numerous and slender.

Fig. 9. *Neritina microstoma*, magnified 150 diameters. 00 . 3 . 1 . 3 . 00; *medians* subquadrate, narrowest towards their bases, subopaque; 1*st laterals* subtrapezoidal, with outer corner most produced; 2*nd laterals* prolonged, strongly curved outwards; 3*rd laterals* convex, broad, glassy, denticulate, with curved tips; *uncini* strong and numerous. Between the 2nd and 3rd laterals there appears to be a smaller or intermediate set of finer uncini; but whether they form a portion of the odontophore, and have become accidentally turned down, or really are another set, we have not been able to determine; the peculiarities, however, of the band appear to have been heretofore overlooked.

Fig. 10. *Adamsiella aripensis*, magnified 300 diameters. 00 . 2 . 1 . 2 . 00. A long slender band; *medians* denticulate, with acute cusps; inner *laterals* broad; outer denticulate on the reflexed edge; *uncini* numerous, slender, curved at their terminations: *a*, separated *uncini*; *b*, inner laterals; *c*, outer laterals, more highly magnified. The mollusk is frequently found suspended by two or three glutinous threads from under branches of low-growing shrubs.

Fig. 11. *Cyclotus translucidus*, magnified 150 diameters. 3 . 1 . 3. A narrow band $\frac{1}{2}$ an inch long; *medians* subquadrate, denticulate, cusps recurved, central ones large and acute; 1*st laterals* broad, more obtuse than the central, recurved, denticulate; 2*nd* & 3*rd laterals* simple, convex, or claw-shaped; bright amber-colour. The animal is of a pinkish colour, which is lighter about the body and foot, but deeper about the tentacles.

Fig. 11*a*. Mandible of *Cyclotus*, magnified 150 diameters. It is divided into two portions by a median articulation, and covered with fine acute denticulations in divergent rows.

Fig. 12. *Cylindrella trinitaria*, magnified 200 diameters. Formula 2 . 1 . 2. A narrow band $\frac{3}{10}$ of an inch in length; *medians* well developed, acute, tricuspid, tubercles on their bases; 1*st laterals*

with simple inconspicuous cusps; 2nd or outer more conspicuous, with recurved claw-shaped cusps.

Fig. 13. *Ampullaria effusa,* magnified 60 diameters. 3 . 1 . 3; *medians* broad, but smaller than those of *A. urceus*; central dentations strong, with three smaller obtuse ones on each side; 1*st laterals* with broad apical dentation on the inner edge, two less developed; 2*nd* & 3*rd laterals* smaller, and claw-shaped. Band $\frac{4}{10}$ of an inch long.

Fig. 14. *Marisa cornu-arietis,* magnified 60 diameters. 3 . 1 . 3. Band $\frac{2}{10}$ of an inch long; *medians* broad, with three dentations on each side of a strong acute central point; 1*st laterals* recurvate, claw-shaped, with three dentations on the inner side of a longer central tooth; 2*nd* & 3*rd* simple claw-shaped, with broad basis firmly set in basement membrane. Mandible very similar to that of *A. effusa.*

W.F. Maples del.

G. Jarman sc.

V. *On the Mechanical Appliances by which Flight is attained in the Animal Kingdom.*

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Read June 6th & 20th, 1867.

(Plates XII.–XV.)

INTRODUCTORY REMARKS.

In entering on the difficult and complicated subject of flight, I have found it advisable to advert briefly to the movements of animals in general. I have adopted this course from a belief that the movements of different animals, like the several orders of organized beings, run into and are linked to each other by analogies and affinities at so many points as to render the consecutive study of them in a measure compulsory. A careful examination, moreover, of the movements and surfaces employed by quadrupeds and fishes in traversing the earth and the water appears to me to supply the peculiar knowledge requisite for analyzing the unusually rapid oscillations of the wings.

In the animal kingdom the movements are adapted either to the land, the water, or the air; and, as a result, the instruments by which they are produced are specially modified. This is necessary because of the different densities and the different degrees of resistance furnished by the land, water, and air respectively. On the land the extremities of animals encounter the *maximum* of *resistance*, and occasion the *minimum* of *displacement*. In the air, on the contrary, the pinions experience the *minimum* of *resistance*, and effect the *maximum* of *displacement*, the water being intermediate both as regards the degree of resistance offered and the amount of displacement produced. It therefore requires a greater degree of muscular exertion to swim than to walk, and a still greater one to fly. For this reason flight is the most laborious and, in some respects, the most involved and intricate of all the animal movements*.

Although all animals do not progress in exactly the same manner, there is nevertheless a similarity and a sequence in their movements which we shall do well to study. This is proved by the fact that most quadrupeds swim as well as run, and some even fly; while many marine animals walk as well as swim, and birds and insects run, swim, and fly indiscriminately. When, however, the land-animals properly so called take to the water or the air habitually, or the inhabitants of the deep seek the land or the air, or the insects and birds which are more peculiarly organized for flight the earth and the water, their organs of locomotion must possess those peculiarities of structure which characterize, as a class, those animals which live on the land, in the sea, or in the air, as happens.

* The efforts made by a bird in flying are always greatest in rising. When once fairly on the wing, flight is rendered comparatively easy by the momentum which the body acquires being made to act in the plane of progression.

In this we have an explanation of the curiously modified hand of the Bat,—of the webbed hands and feet of the Otter, Ornithorhynchus, Seal, and Walrus,—of the expanded tail of the Whale, Porpoise, Dugong, and Manatee,—of the feet of the Ostrich, Apteryx, and Dodo, exclusively designed for running,—of the feet of the Ducks, Gulls, and Petrels, specially adapted for swimming,—and of the wings and feet of the Penguins, Auks, and Guillemots, especially designed for diving. Other and intermediate modifications occur in the Flyingfish, Flying Lizard, and Flying Squirrel; and some animals, as the Frog, Newt, and several of the aquatic insects (the Ephemera or May-fly for example *), which begin their career by swimming, come ultimately to walk, leap, and even fly†.

Every degree and variety of motion, therefore, which is peculiar to the land, and to the sea and air-navigating animals as such, is imitated by others which take to the elements in question secondarily or at intervals.

As the space at my disposal will not admit of my going into the several arrangements by which locomotion is attained in the animal kingdom as a whole, I will allude only to such as illustrate in a progressive manner the several kinds of motion on the land and in or on the water, reserving for the third and concluding part of the paper the subject of flight as exemplified in the insect, bat, and bird.

The following, among other animals, have been referred to, and their movements, whether on land, on or in the water, or air, for the most part described and figured. They may be hastily classified as follows :—

Land Animals.—The Horse, Ox, Deer, Kangaroo, Giraffe, Serpent, &c.

Land and Water.—The Otter, Ornithorhynchus, Seal, Sea-Bear, Walrus, Beaver, Penguin, Turtle, Triton, Crocodile, Frog, &c.

Land and Air.—The Dragon or Flying Lizard, Galeopithecus or Flying Cat, Pterodactyle, Bat, &c.

Water.—The Whale, Dugong, Manatee, Porpoise, Trout, Sturgeon, Shark, Ray, Stickleback, Pipefish, Proteus, Axolotl, Lepidosiren, Medusa, Rotifera, Protozoa, &c.

Air.—(Insects) The Beetle, *Alucita hexadactyla*, Moth, Water-Scorpion, Cicada, Locust, Dragonfly, Butterfly, &c. (Bats) The Bat. (Birds) The Bearded Vulture, Kestrel, Heron, Owl, Crow, Plover, Partridge, Pigeon, Curlew, Snipe, Swallow, Humming-bird, Swan, Goose, Duck, Albatros, Gull, Kingfisher, Guillemot, Loon, Grebe, &c.

I am indebted for my illustrations (Plate XIV., which is from photographs by myself, excepted) to the spirited pencil of my friend Mr. C. Berjeau.

* "The Ephemeræ in the larva- and pupa-state reside in the water concealed during the day under stones or in horizontal burrows which they form in the banks. Although resembling the perfect insect in several respects, they differ materially in having longer antennæ, wanting ocelli, by possessing horn-like mandibles; the abdomen has, moreover, on each side a row of plates, mostly in pairs, which are a kind of false branchiæ, and which are employed not only in respiration, *but also as paddles*."—Cuvier's Animal Kingdom, p. 576. London, 1840.

† Kirby and Spence observe that some insects which are not naturally aquatic, do, nevertheless, swim very well if they fall into the water. They instance a kind of grasshopper (*Acrydium*), which can paddle itself across a stream with great rapidity by the powerful strokes of its hind legs. (Introduction to Entomology,' 5th edit., 1828, p. 360.) Nor should the remarkable discovery by Sir John Lubbock, of a swimming insect (*Polynema natans*) which uses its wings entirely as fins, be overlooked. (Linn. Trans. vol. xxiv. p. 135.)

The figures, which have been executed with extreme care, are, with very few exceptions, from the specimens themselves, either living or dead. They are 78 in number; and of these 72 are original.

I have also to thank Mr. A. D. Bartlett, the intelligent and zealous superintendent of the Zoological Society's splendid collection,—that gentleman having, with characteristic urbanity, on various occasions enabled me to study the movements of the animals placed more immediately under his care, under unusually favourable circumstances.

Lastly, I have to acknowledge my unqualified obligations to my friend and former colleague, Dr. James Murie, the prosector to the Zoological Society, whose advice, time, and valuable services have on all occasions been unreservedly placed at my disposal.

LOCOMOTION ON LAND.

Walking of the Quadruped, Biped, Reptile, &c.—As the earth, because of its solidity, will bear any amount of pressure to which it may be subjected, the size, shape, and weight of animals destined to traverse its surface are matters of little or no consequence. As, moreover, the surface trod upon is rigid or unyielding, the extremities of quadrupeds are, as a rule, terminated by small feet (Plate XII. fig. 1). In this there is a double purpose—the limited area presented to the ground affording the animal sufficient support and leverage, and enabling it to disentangle its feet with the utmost facility, it being a condition in rapid terrestrial progression that the points presented to the earth should be few in number and limited in extent, as this approximates the feet of animals most closely to the wheel in mechanics, where the surface in contact with the plane of progression is reduced to a minimum. When the surface presented to a dense resisting medium is increased, speed is diminshed, as shown in the tardy movements of the mollusk, caterpillar, and slowworm, and also, though not to the same extent, in the Serpents, some of which move with considerable celerity. In the Gecko and common House-fly, as is well known, the travelling surfaces are furnished with suctorial disks, which enable the animals to walk, if need be, in an inverted position; and "the Tree-frogs (*Hyla*) have a concave disk at the end of each toe, for climbing and adhering to the bark and leaves of trees. Some Toads, on the other hand, are enabled, by peculiar tubercles or projections from the palm or sole, to clamber up old walls"*. A similar, but more complicated, arrangement is met with in the arms of the Cuttlefish.

The movements of the extremities in land-animals vary according to class and the degree of speed aimed at.

In the Kangaroo the posterior extremities only are used, and the animal advances *per saltum*, or by a series of leaps. In the Giraffe the legs of opposite sides move together and alternate, whereas in the pace known as the trot the extremities move diagonally—a remark which holds true also of ourselves in walking and skating, the right leg and left arm advancing together and alternating with the left leg and right arm. In the hexapod insects, according to Müller, the fore and hind foot of the one side and the middle one

* Comp. Anat. and Phys. of Vertebrates, by Professor Owen, vol. i. pp. 262–263. Lond. 1866.

of the opposite side move together to make one step, the three corresponding and opposite feet moving together to form the second step. Other and similar combinations are met with in the decapods.

The alternating movements of the extremities is interesting as betokening a certain degree of flexuosity or twisting either in the trunk or limbs, or partly in the one and partly in the other. In order to understand the twisting which occurs to a greater or less extent in the bodies and extremities (when present) of all vertebrated animals, it is necessary to reduce the bony and muscular systems to their simplest expression. If motion is desired in a dorsal, ventral, or lateral direction only, a dorsal, ventral, or a right and left lateral set of muscles acting upon straight bones articulated by an ordinary ball-and-socket joint will suffice. In this case the dorsal, ventral, and right and left lateral muscles form *muscular cycles**, contraction on the one aspect of the cycle being accompanied by relaxation on the other, the bones and joints forming as it were the diameters of the cycles, and oscillating in a backward, forward, or lateral direction in proportion to the degree and direction of the contraction †. Here the motion is confined to two planes intersecting each other at right angles. When, however, the muscular system becomes more highly differentiated, both as regards the number of the muscles and the variety of the directions pursued by them, the bones and joints also become more complicated. Under these circumstances, the bones in many instances are twisted upon

* The cyclical arrangement of the fibres here referred to is clearly traceable in the hollow viscera of Vertebrates, particularly in the heart, stomach, and bladder.—"On the arrangement of the Muscular Fibres in the Ventricles of the Vertebrate Heart, with Physiological remarks," by the Author, Phil. Trans. 1864; "On the arrangement of the Muscular Fibres in the Tunics of the Stomach in Man and other Mammalia," by the Author, Proc. Roy. Soc. 1867; "On the Muscular arrangements of the Bladder and Prostate, and the manner in which the Ureters and Urethra are closed," by the Author, Phil. Trans. 1867.

† The bones and joints, it may be remarked, are not necessary to locomotion. In the Protozoa or cell-animals this is effected by an amorphous contractile mass; in the worm, leech, and caterpillar by imperfect muscular fibres *continuous upon themselves*, as in the hollow viscera of Vertebrates—the cyclical arrangement of the text. The muscle becomes interrupted in the Crustaceans by the interposition of an external, and in the Vertebrata by the addition of an internal skeleton. When, therefore, the external and internal skeletons make their appearance, it is to afford the muscular system additional surface and leverage, and to enable it to act with greater precision in a given direction. The skeleton, since it cannot move of itself, is consequently to be regarded as an adjunct or auxiliary of the muscular system. As the muscles are accurately moulded to the bones and to each other, either directly or indirectly (by tendons), and the joints and muscles move in perfect harmony, while the bones are unyielding or rigid, it follows that the osseous system acts as a break or boundary to the muscular one,—and hence the arbitrary division of muscles into extensors and flexors, pronators and supinators, abductors and adductors. Instead, however, of dividing the muscles into sets, it would be more intelligible and, I believe, more philosophical to regard them (as has been done in the text) as forming muscular circles or cycles interrupted by processes of bone, whose articular surfaces transmit the motion which is generated on the one side of the circle to the other. If this plan be adopted, the voluntary system of muscles is readily assimilated to the involuntary, and both are referred to their original, the *continuous elementary fibre*. This view is favoured by analogy and by the fact that the muscular system in the higher Vertebrates is in a state of tonicity, *i. e.* equally balanced or oscillating between two imaginary fixed points, and ready to act, through its extensors and flexors, abductors and adductors, pronators and supinators, with surprising rapidity, the contraction of the extensors on all occasions involving the relaxation of the flexors, and so of the others. The most highly organised animal may in this sense be regarded as a living mass whose parts (hard, soft, and otherwise) are accurately adapted to each other, every part reciprocating with scrupulous exactitude, and rendering it difficult to determine where motion begins and where it terminates.

themselves, and their articular surfaces present various degrees of spirality to meet the requirements of the muscular system. Between the straight muscles, therefore, arranged in dorsal, ventral, and right and left lateral sets, and those which run in a more or less transverse direction, and between the simple joint whose motion is confined to one plane and the ball-and-socket joint whose movements are universal, every degree of obliquity is found in the direction of the muscles, and every possible modification in the disposition of the articular surfaces. In the fish the muscles are for the most part arranged in dorsal, ventral, and lateral sets, which run longitudinally; and, as a result, the movements of the trunk, particularly towards the tail, are from side to side and sinuous. As, however, oblique fibres are also present, and the tendons of the longitudinal ones in some instances cross obliquely towards the tail, the fish has also the power of tilting or twisting its trunk (particularly the lower half) as well as the caudal fin*. The spinal column facilitates the lateral sinuous twisting movements of the tail and trunk, from the fact of the vertebræ composing it being united to each other by a series of modified universal joints—the vertebræ supplying the cup-shaped depressions or sockets, the intervertebral substance the prominence or ball.

The same may be said of the general arrangement of the muscles in the trunk and tail of the Cetacea, the principal muscles in this case being distributed, not on the sides, but on the dorsal and ventral aspects. The lashing of the tail in the Whales is consequently from above downwards or vertically, instead of from side to side. The spinal column is jointed as in the fish, with this difference, that the vertebræ (especially towards the tail) form the rounded prominences or ball, the meniscus or cup-shaped intervertebral plates the receptacles or socket.

When limbs are present, the spine may be regarded as being ideally divided, the spiral movements, under these circumstances, being thrown upon the extremities by typical ball-and-socket joints occurring at the shoulder and pelvis. This is peculiarly the case in the Seal, where the spirally sinuous movements of the spine are transferred directly to the posterior extremities †.

* In a Mackerel which I examined, the oblique muscles were represented by the four lateral masses occurring between the dorsal, ventral, and lateral longitudinal muscles—two of these being found on either side of the fish, and corresponding to the myocommas or "*grand muscle latéral*" of Cuvier. The muscular system of the fish would therefore seem to be arranged on a fourfold plan,—there being four sets of longitudinal muscles, and a corresponding number of slightly oblique and oblique muscles, the oblique muscles being spiral in their nature and tending to cross or intersect at various angles, an arrest of the intersection, as it appears to me, giving rise to the myocommas and to that concentric arrangement of their constituent parts so evident on transverse section. This disposition of the muscular fibres to cross each other at various degrees of obliquity may also be traced in several parts of the human body, as, for instance, in the deltoid muscle of the arm and the deep muscles of the leg. Numerous other examples of penniform muscles might be adduced. Although the fibres of the myocommas have a more or less longitudinal direction, the myocommas themselves pursue an oblique spiral course from before backwards and from within outwards, *i. e.* from the spine towards the periphery, where they receive slightly oblique fibres from the longitudinal dorsal, ventral, and lateral muscles. As the spiral oblique myocommas and the oblique fibres from the longitudinal muscles act directly and indirectly upon the spines of the vertebræ, and the vertebræ themselves, to which they are specially adapted, and as both sets of oblique fibres are geared by interdigitation to the fourfold set of longitudinal muscles, the lateral, sinuous, and rotatory movements of the fish referred to in the text are readily accounted for.

† That the movements of the extremities primarily emanate from the spine is rendered probable by the remarkable

The extremities, when present, are provided with their own muscular cycles of extensor and flexor, abductor and adductor, pronator and supinator muscles,—these running longitudinally and at various degrees of obliquity, and enveloping the hard parts according to their direction—the bones being twisted upon themselves and furnished with articular surfaces which reflect the movements of the muscular cycles, whether these occur in straight lines anteriorly, posteriorly, or laterally, or in oblique lines in intermediate situations. The straight muscles are principally brought into play in the extension and flexion of the extremities of quadrupeds in walking, and the oblique ones in the twisting of the pectoral fins of fishes and the flippers of the Whales and Seals in balancing and swimming, and the wings of insects, bats, and birds in flying. The straight and oblique muscles are usually found in combination, and cooperate in producing the movements in question, the amount of rotation in a part always increasing as the oblique muscles preponderate. It is with a view to preparing the reader for the peculiar and complicated spiral and rotatory movements of the wings that this digression on muscular arrangements and actions has been thought desirable. The combination of ball-and-socket and hinge-joints, with their concomitant oblique and non-oblique muscular cycles (the former occurring in their most perfect forms where the extremities are united to the trunk, the latter in the extremities themselves), enables the animal to present, when necessary, an extensive resisting surface and a greatly diminished and comparatively non-resisting one, and secures that subtlety and nicety of motion demanded by the several media at different stages of progression.

In those land-animals which take to the water occasionally, or the reverse, the feet, as a rule, are furnished with membranous expansions extending between the toes. Of such the Otter (Plate XII. fig. 2), Ornithorhynchus (Plate XII. fig. 3), Seal (Plate XII. fig. 4), Crocodile, Sea-Bear (Plate XII. fig. 6), Walrus, Frog, and Triton (Plate XII. fig. 8) may be cited. The Crocodile and Triton, in addition to the membranous expansion occurring between the toes, are supplied with a powerful swimming-tail, which adds very materially to the extent of surface engaged in natation. Those animals, one and all, walk awkwardly, it always happening that when the extremities are modified to operate upon two essentially different media (as, for instance, the land and water), the maximum of speed is attained in neither. For this reason those animals which swim the best, walk, as a rule, with the greatest difficulty, and *vice versâ*, as the movements of the Auk and Seal in and out of the water amply testify.

In addition to those land-animals which run and swim, there are some which precipitate themselves, parachute-fashion, from immense heights, and others which even fly. In these the membranous expansions are greatly increased, the ribs affording the necessary support in the Dragon or Flying Lizard (Plate XIII. fig. 13), the anterior and posterior

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powers possessed by Serpents. "It is true," writes Professor Owen (*op. cit.* p. 261), "that the serpent has no limbs, yet it can outclimb the monkey, outswim the fish, outleap the jerboa, and, suddenly loosing the close coils of its crouching spiral, it can spring into the air and seize the bird upon the wing." * * * "The serpent has neither hands nor talons, yet it can outwrestle the athlete, and crush the tiger in the embrace of its ponderous overlapping folds." The peculiar endowments, therefore, which accompany the possession of extremities would seem to present themselves in an undeveloped or latent form in the trunk of the reptile.

extremities and tail in the Flying Lemur (Plate XIII. fig. 18) and Bat (Plate XIII. fig. 15). Although no Lizard is at present known to fly, there can be little doubt that the extinct Pterodactyles (which, according to Professor Huxley, are intermediate between the Lizards and Crocodiles) were possessed of this power. The Bat is interesting as being the only mammal at present enjoying the privilege of flight*. It affords an extreme example of modification for a special purpose,—its attenuated body, dwarfed posterior and greatly elongated anterior extremities, with their enormous fingers and outspreading membrane, completely unfitting it for terrestrial progression. It is instructive as showing that flight may be attained, without the aid of hollow bones and air-sacs, by purely muscular efforts, and by the mere contraction and dilatation of a continuous membrane. The structure and action of the Bat's wing are fully described at a subsequent page.

PROGRESSION ON AND IN THE WATER.

If we direct our attention to the water, we encounter a medium less dense than the earth and considerably more dense than the air. As this element, in virtue of its fluidity, yields readily to external pressure, it follows that a certain relation exists between it and the shape, size, and weight of the animal progressing along or through it, those animals making the greatest headway which are of the same specific gravity, or a little heavier, and are furnished *with extensive surfaces* which, by a dexterous tilting or twisting (for the one implies the other), or by a sudden contraction and dilatation, they can apply wholly or in part to obtain the maximum of resistance in the one direction, and the minimum of displacement in the other. This arises from the fact, first pointed out by Sir Isaac Newton, that bodies or animals moving in water and likewise in air experience a sensible resistance, which is greater or less in proportion to the density and tenacity of the fluid and the figure, superficies, and velocity of the animal.

To obtain the degree of resistance and non-resistance necessary for progression in water, Nature, never at fault, has devised some highly ingenious expedients,—the Syringograde animals advancing by alternately sucking up and ejecting the water in which they are immersed—the Medusæ by a rhythmical contraction and dilatation of their mushroom-shaped disk—the Rotifera or wheel-animalcules by a vibratile action of their cilia, which, according to the late Professor Quekett, twist upon their pedicles so as alternately to increase and diminish the extent of surface presented to the water, as happens in the feathering of an oar. A very similar plan is adopted by the Pteropoda, found in countless multitudes in the northern seas, which, according to Eschricht, use the wing-like structures situated near the head after the manner of a double paddle, resembling in its general features that at present in use among the Greenlanders. The characteristic movement, however, and that adopted in by far the greater number of instances, is that commonly seen in the fish (Plate XII. fig. 11). This, as my readers are aware, consists of a lashing, curvilinear, or flail-like movement of the broadly expanded tail, which oscillates from side to side of the body, in some instances with immense speed and power. The

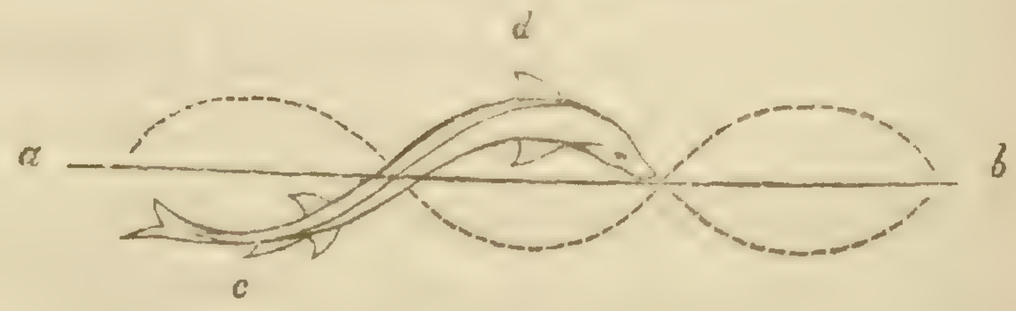
* The Vampire Bat of the island of Bonin, according to Dr. Buckland, can also swim; and this authority was of opinion that the Pterodactyle enjoyed similar advantages (Eng. Cycl. vol. iv. p. 495).

muscles in the fish, as has been explained, are for this purpose arranged along the spinal column, and constitute the bulk of the animal, it being a law that when the extremities are wanting, as in the Water-snake, or rudimentary, as in the fish (Plate XII. fig. 11), Lepidosiren*, Proteus, and Axolotl, the muscles of the trunk are largely developed, the onus of locomotion, as a consequence, falling chiefly, if not entirely, upon the tail and lower portion of the body. The operation of this law is well seen in the metamorphosis of the Tadpole, the muscles of the trunk and tail becoming modified, and the tail itself disappearing as the limbs of the perfect Frog are developed. The same law likewise prevails in certain instances where the anterior extremities are comparatively perfect, as in the Whale, Porpoise (Plate XII. fig. 10), Dugong, and Manatee (Plate XII. fig. 9), and where both anterior and posterior extremities are perfect, as in the Crocodile, Triton (Plate XII. fig. 8), and Salamander. The Whale, Porpoise, Dugong, and Manatee employ their anterior extremities in balancing and turning, the great organ of locomotion being the tail. The same may be said of the Crocodile, Triton, and Salamander, these using their extremities in quite a subordinate capacity as compared with the tail. The peculiar movements of the trunk and tail in swimming are seen to most advantage in the fish, and may now be briefly described.

Swimming of the Fish, Whale, Porpoise, &c.—When the fish gathers itself together, preparatory to making the stroke which sends it forwards, it bends or flexes its tail laterally, not, as is commonly represented†, by throwing its body into a single curve (Diagram 1, *c*), whose convexity is turned in the direction of the mesial line of

Diagram 1.

Diagram 2.



the fish (*a b*), and which would have the effect of projecting it along the arc of a circle (*c d*), but by converting it into a double curve (Diagram 2, *c d*), the convexities of both of which are directed away from the line in question (*a b*). The object of this arrangement is twofold:—first, to insure that the fish shall pursue a comparatively straight course, its head and tail oscillating on either side of a given line (*a b*); and secondly, to diminish the amount of resistance experienced by the upper and lower portions of the body during flexion, or when the back stroke is being made, the resistance occasioned by a concave surface (*c* of Diagram 1) as compared with a convex one (*c* of Diagram 2) being as nearly as possible as two to one. The resistance encountered during the back stroke is further diminished by the body being made to rotate slightly, so as to present

* The *Lepidosiren* is furnished with two tapering flexible stem-like bodies, which depend from the anterior ventra aspect of the animal, the *Siren* having in the same region two pairs of rudimentary limbs furnished with four imperfect toes, while the *Proteus* has anterior extremities armed with three toes each, and a very feeble posterior extremity terminating in two toes.

† Borelli, 'De motu Animalium,' plate iv. fig. 5, sm. 4to, 2 vols., Romæ, 1680; Cyc. Anat. & Phys. vol. iii. art. "Motion," by Bishop, p. 438; Owen, *op. cit.* pp. 252–253.

it obliquely to the water, the tail meanwhile twisting upon itself and being in some instances more or less compressed vertically. During extension, or when the effective stroke is delivered, these conditions are reversed; the body is retilted so as to apply its flat or maximum of surface, and the curves into which it was thrown reduced by a violent recoil, in which the concavity or biting surface of the tail is vigorously urged from right to left, and the corresponding surface of the head from left to right, or the reverse.

When the head and tail travel beyond the axis of motion—and by this I mean an imaginary line (say *a b* of Diagrams) on either side of which they oscillate—the curves are gradually reversed and the back stroke commenced. The axis of motion, therefore, corresponds with the long axis of the fish when the body is straight. It is to this line that the movements of the fish are to be referred, the upper and lower portions of the body being curved and carried away from it in flexion (Diagram 2, *c d*), and straightened and forced towards it during extension. The double curve or spiral into which the fish throws itself when swimming may be conveniently divided into an upper or cephalic curve (Diagram 2, *d*) and a lower or caudal one (*c*). When the concavity of the caudal curve is biting or laying hold of the water, and when the concave surface of the tail is being forced during extension with great violence in the direction of the axis of motion (*a b* of Diagram 2), where the concave surface is suddenly converted into a convex one, the concavity of the cephalic curve, *i. e.* the concave surface of the upper half of the fish, is being urged with less vigour in the direction of the same line from the opposite side of it. As the caudal and cephalic curves are obliterated when the line in question is reached, there is consequently a period (momentary it must be) between the effective and non-effective strokes in which the body of the fish is comparatively straight, and consequently in a position to advance almost without impediment. When, further, the tail is being forced from right to left of the axis of motion, the head is reciprocating by travelling in a contrary direction, or from left to right, the head and tail and the cephalic and caudal curves complementing each other. I shall perhaps be better understood if I say the concave surfaces of the cephalic and caudal portions of the fish bite or seize the water at the same time, the cephalic concave surface in conjunction with the water affording the resistance or *point d'appui* necessary for the effective action of the concave surface of the tail, while it conducts the head in an opposite direction to the tail, the upper part of the body acting as a guide or pilot to the lower portion. The fish has, therefore, every part of its body perfectly under control, both during extension, when the effective stroke is given, and during flexion, when the non-effective, or back stroke, is made. The terms extension and flexion, I may remark, are commonly confined to the lateral oscillations of the lower half of the body. This, however, is a mistake, since the head and upper half are likewise extended and flexed, the only difference between the extension and flexion of the upper and lower portions of the body amounting to this, that they occur on the opposite sides of a straight line—this line corresponding to the axis of motion. It is a curious circumstance, and as suggestive as curious, that this is precisely what happens in the axillary and distal curves of the anterior and posterior margins of the wing of the bird in extension and flexion (*vide infrà*). A certain analogy may therefore be traced between the water and air as media, and between the trunk and

extremities as instruments of locomotion. From this it follows that the water and air are acted upon by curves or wave-pressure emanating in the one instance from the body of the fish, and in the other from the wing of the bird, the reciprocating and opposite curves into which the trunk and wing are thrown in swimming and flying constituting in reality a *mobile helix* or *screw*, which, during its action, produces the precise kind and degree of pressure adapted to fluid media, and to which they respond with the greatest readiness. The whole body of the fish is thrown into action in swimming; but as the tail and lower half of the trunk are more free to move than the head and upper half, which are more rigid, and because the tendons of many of the trunk-muscles are inserted into the tail, the oscillation is greatest in the direction of the latter. The muscular movement travels in a spiral wave from before (Plate XII. fig. 11) backwards; and this, reacting upon the water, causes the fish to glide forwards in a series of curves. Since the head and tail, as has been stated, always travel in opposite directions, and the fish is constantly alternating or changing sides, it in reality describes a spiral course, as represented in Plate XV. fig. 76. These remarks may be readily verified by a reference to the swimming of the Sturgeon (Diagram 2, p. 204), whose movements are unusually deliberate and slow. The number of curves into which the body of the fish is thrown in swimming is increased in the long-bodied fishes, as the Eels, and decreased in those whose bodies are short or are comparatively devoid of flexibility. In proportion as the curves into which the body is thrown in swimming are diminished, the degree of rotation at the tail or in the fins is augmented, some fishes, as the Mackerel, using the tail very much after the manner of a screw in a steam-ship. The fish may thus be said to drill the water in two directions, viz. from behind forwards by a twisting or screwing of the body on its long axis, and from side to side by causing its anterior and posterior portions to assume opposite curves. The pectoral and other fins are also thrown into curves in action, the movement, as in the body itself, travelling in spiral waves; and it is worthy of remark that the wing of the insect, bat, and bird obeys similar impulses, the pinion, as I shall show presently, being essentially a spiral organ.

The twisting of the pectoral fins is well seen in the common Perch (*Perca fluviatilis*), and still better in the 15-spined Stickleback (*Gasterosteus spinosus*), which latter frequently progresses by their aid alone*. In the Stickleback the pectoral fins are so delicate and are plied with such vigour that the eye is apt to overlook them, particularly when in motion. The action of the fins can be reversed at pleasure, so that it is by no means an unusual thing to see the Stickleback proceeding tail first. The fins are rotated or twisted, and their free margins lashed about by spiral movements which closely resemble those by which the wings of insects are propelled†. The rotating of the fish upon its long axis is

* The *Syngnathi*, or Pipefishes, swim chiefly by the undulating movement of the dorsal fin.

† If the pectoral fins are to be regarded as the homologues of the anterior extremities (which they unquestionably are), it is not surprising that in them the spiral rotatory movements which are traceable in the extremities of quadrupeds, and so fully developed in the wings of bats and birds, should be clearly foreshadowed. "The muscles of the pectoral fins," remarks Professor Owen, "though, when compared with those of the homologous members in higher vertebrates, they are very small, few, and simple, yet suffice for all the requisite movements of the fins—elevating, depressing, advancing, and again laying them prone and flat, by an oblique stroke, upon the sides of the body. The rays or

seen to advantage in the Shark and Sturgeon, the former of which requires to turn on its side before it can seize its prey,—and likewise in the Pipefish, whose motions are unwontedly sluggish. The twisting of the tail is occasionally well marked in the swimming of the Salamander. In the Whale*, Porpoise (Plate XII. fig. 10), Dugong, and Manatee (Plate XII. fig. 9) the movements are strictly analogous to those of the fish, the only difference being that the tail acts from above downwards, or vertically instead of from side to side or laterally. The anterior extremities, which in those animals are comparatively perfect, are rotated on their long axis, and applied obliquely and non-obliquely to the water, as in the Seal, Sea-Bear, and Walrus, and assist in balancing and turning the animal. Natation, however, is performed almost exclusively by the tail and lower half of the trunk—the tail of the Whale exerting prodigious power. It is otherwise with the Rays, where the hands are principally concerned in progression. In the Beaver the tail is flattened from above downwards as in the foregoing mammals, but in swimming it is made to act upon the water laterally as in the fish. The tail of the bird, which is also compressed from above downwards, can be twisted obliquely, and when in this position may be made to perform the office of a rudder.

Swimming of the Seal, Sea-Bear, and Walrus.—In the Seal (Plate XII. fig. 4) the anterior and posterior extremities are more perfect than in the Whale, Porpoise, Dugong, and Manatee; the general form, however, and mode of progression (if the fact of its occasionally swimming on its back be taken into account) is essentially fish-like. A peculiarity is met with in the swimming of the Seal, to which I think it proper to direct attention. When the lower portion of the body and posterior extremities of these creatures are flexed and tilted, as happens during the back or non-effective stroke, the naturally expanded feet are more or less completely closed or pressed together, in order to diminish the extent of surface presented to the water, and, as a consequence, to reduce the resistance produced. The feet are opened to the utmost during extension, when the effective stroke is given, in which case they present their maximum of surface.

The swimming-apparatus of the Seal is therefore more highly differentiated than that of the Whale, Porpoise, Dugong, or Manatee; the natatory tail in these animals being, from its peculiar structure, incapable of lateral compression†. It would consequently appear that the swimming-appliances of the Seals (where the feet open and close as in swimming birds) are to those of the sea-mammals generally what the feathers of the bird's wing (these also open and close in flight) are to the continuous membrane forming the wing of the insect and Bat.

The anterior extremities or flippers of the Seal are not employed in swimming, but only in balancing and in changing position. The fore feet also open and close in natation, though not to the same extent as the hind ones; and the resistance and non-resistance necessary are secured by a partial rotation and tilting of the flippers. By this twisting

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digits of both pectorals and ventrals (the homologues of the posterior extremities) can be divaricated and approximated, and the intervening webs spread out or folded up."—*Op. cit.* vol. i. p. 252.

* *Vide* remarks on the swimming of Cetaceans, by Dr. Murie, Proc. Zool. Soc. 1865, pp. 209–210.

† In a few instances the caudal fin of the fish, as has been already stated, is more or less pressed together during the back stroke, the compression and tilting or twisting of the tail taking place synchronously.

and untwisting, the narrow edges and flatter portions of the flippers are applied to the water alternately. The rotating and tilting of the anterior and posterior extremities, and the opening and closing of the hands and feet in the balancing and swimming of the Seal, form a series of strictly progressive and very graceful movements. They are, however, performed so rapidly, and glide into each other so perfectly, as to render an analysis of them exceedingly difficult.

In the Sea-Bear (*Otaria Hookeri*) (Plate XII. fig. 6), the anterior extremities attain sufficient magnitude and power to enable the animal to progress by their aid alone—the feet and the lower portions of the body being moved only sufficiently to maintain, correct, or alter the course pursued.

This remarkable creature, which I have repeatedly watched at the Zoological Gardens*, uses its hands as paddles, the universal joint by which the arm is attached to the shoulder enabling it, by a partial rotation and twisting of the extremity (Plate XV. fig. 51 *c*), to present the palm or flat of the hand to the water at one instant and the edge or narrow part the next. In swimming, the anterior or thick margin of the flipper is *directed downwards* as in the anterior extremities of the Walrus, Great Auk, and Turtle (Plate XII. fig. 7)†.

The flippers are advanced alternately; and the twisting screw-like movement which they exhibit in action, and which I have carefully noted on several occasions, bears considerable resemblance to the motions witnessed in the pectoral fins of fishes. It may be remarked that the twisting or spiral movements of the anterior extremities are calculated to utilize the water to the utmost—the gradual but rapid operation of the helix enabling the animal to lay hold of the water and disentangle itself with astonishing facility, and with the minimum expenditure of power. In fact the insinuating motion of the screw is the only one which can contend successfully with the liquid element; and it appears to me that this remark holds even more true of the air. It also applies within certain limits, as has been explained, to the land. The Otaria or Sea-Bear swims with remarkable address and with apparently equal ease in an upward, downward, and horizontal direction by muscular efforts alone—an observation which may likewise be made regarding a great number of fishes, since the swimming-bladder or float is in many entirely absent‡. The Walrus, a living specimen of which I had an opportunity of frequently examining, is nearly allied to the Seal and Sea-Bear, but differs from both as regards its manner of swimming. The natation of this rare and singularly interesting animal, as I have taken great pains to satisfy myself, is effected by a mixed movement—the anterior and posterior extremities participating in nearly an equal degree. The anterior extremities or flippers of the Walrus morphologically resemble those of the Seal, but physiologically those of

* The unusual opportunities afforded by this unrivalled collection have enabled me to determine with something like accuracy the movements of the various land-animals, as well as the motions of the wings and feet of birds, both in and out of the water. I have also studied under the most favourable circumstances the movements of the Otter, Sea-Bear, Seal, Walrus, Porpoise, Turtle, Triton, Crocodile, Frog, Lepidosiren, Proteus, Axolotl, and the several orders of fishes.

† This is the reverse of what takes place in flying, the anterior or thick margin of the wing being invariably ***directed upwards.***

‡ The air-bladder is wanting in the Dermopteri, Plagiostomi, and Pleuronectidæ. (Owen, *op. cit.* p. 255.)

the Sea-Bear; while the posterior extremities possess many of the peculiarities of the hind legs of the Sea-Bear, but display the movements peculiar to those of the Seal. In other words, the anterior extremities or flippers of the Walrus are moved alternately, and reciprocate, as in the Sea-Bear: *i. e.* they are carried away from the body, and advanced during extension, when the back or non-effective stroke is made, and drawn towards the body and retracted during flexion, when the effective or forward stroke is given; they are, further, rotated on their long axes, or tilted, during either movement, so as to present their maximum and minimum of surface to the water alternately. The posterior extremities, on the other hand, are lashed from side to side by a twisting curvilinear motion, precisely as in the Seal. The Walrus may therefore, as far as the physiology of its extremities is concerned, very properly be regarded as holding an intermediate position between the Seals on the one hand and the Sea-Bears or Sea-Lions on the other.

Swimming of the Turtle, Triton, Crocodile, &c.—The swimming of the Turtle (Plate XII. fig. 7) differs in some respects from that of all the others. While the anterior extremities of this quaint animal move alternately, and tilt or partially rotate during the effective and non-effective strokes, as in the Sea-Bear and Walrus, the posterior extremities likewise move by turns. As, moreover, the anterior extremity of one side and the posterior extremity of the opposite side move together, and reciprocate with the corresponding members of the other side, the creature has the appearance of walking in the water. The same remarks apply to the movements of the extremities of the Triton and Crocodile, when swimming, and to the feebly developed corresponding members in the Lepidosiren, Proteus, and Axolotl, specimens of all of which are to be seen at present in the Zoological Society's Gardens. In these, however, natation is effected principally, if not altogether, by the tail and lower half of the body, which is largely developed and flattened laterally for this purpose, as in the fish.

The muscular power exercised by the fishes, the Cetaceans, and the Seals, in swimming, is conserved to a remarkable extent by the momentum which the body rapidly acquires—the velocity attained by the mass diminishing the degree of exertion required in the individual or integral parts. This holds true of all animals, whether they move on the land or on or in the water or air*.

The animals which furnish the connecting link between the water and the air are the Flyingfishes (Plate XII. fig. 12) on the one hand and the diving birds (Plate XII. fig. 5) on the other,—the former sustaining themselves for considerable intervals in the air by means of their enormous pectoral fins, the latter using their wings for flying above and through the water, as occasion demands†.

* A good illustration of the enormous speed and force acquired by a fish in motion may be seen in the Museum of the Royal College of Surgeons of England, where a portion of the timbers of one of Her Majesty's ships is exhibited having the tusk of a Sword-fish imbedded in it. On this occasion the formidable weapon perforated the copper sheathing, a layer of felt, 4 inches of deal, and 14 inches of oaken plank.

† The Steamer or Race-horse Duck (*Micropterus brachypterus*) constitutes a striking link between the genera *Anas* and *Aptenodytes*, alike because of its great swimming- and diving-powers, and because of its short and remarkably small wings, which are useless as organs of flight, and serve to propel it along rather than through the water. (English Cyclopædia of Natural History, vol. iii. p. 810.)

Flight of the Flyingfish &c.—Whether the Flyingfish uses its greatly expanded pectoral fins as a bird its wings, or only as parachutes, has not, so far as I am aware, been determined by actual observation. Most observers are of opinion that these singular creatures glide up the wind and do not beat it after the manner of birds; so that their flight (or, rather, leap) is indicated by the arc of a circle, the sea supplying the chord. I have carefully examined the structure, relations, and action of those fins, and am satisfied in my own mind that they act as true pinions within certain limits, their inadequate dimensions only preventing them from sustaining the fish in the air for an indefinite period—at all events so long as they remain moist. When the fins are fully flexed, as happens when the fish is swimming, they are arranged along the sides of the body; but when it takes to the air, they are raised above the body and make a certain angle with it. In being raised they are likewise turned outwards, the fin rotating on its axis until it makes an angle of something like 30° with *the horizon*—this being, as nearly as I can determine, the greatest angle made by the wing during the effective or down stroke in the flight of insects and birds*. The angle which the wing makes with the long axis of *the body*, from the fact of the trunk being usually inclined obliquely upwards in flight, is considerably less than 30°, and probably does not exceed 15° or 20°. It varies, however, during the flexion and extension of the wing, and also, though in a less degree, during the down and up strokes—the angle being gradually increased when the wing descends, and correspondingly decreased when it ascends. It is further determined by the absence or presence of atmospheric currents, by the shape and size of the body, the expanse of wing, and the rapidity of flight, as shown in the annexed woodcuts.

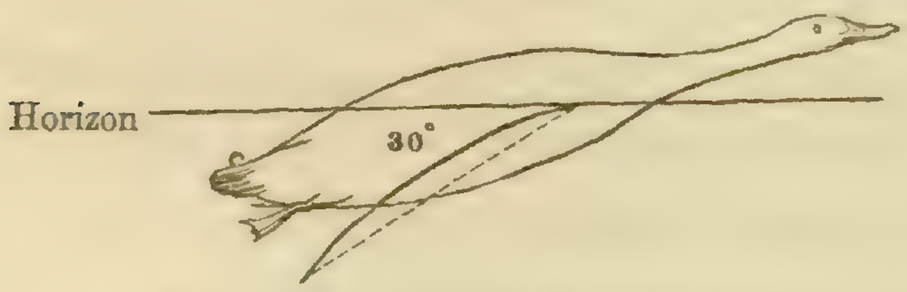

Diagram 3.—Duck in ordinary flight.

Diagram 4.—Duck in rapid flight.

The angle assigned must therefore be regarded as only approximately true. The increase or diminution of the angle made by the wing and by the body with the horizon in flight enables the insect and bird to balance themselves with remarkable adroitness, and to maintain or alter their position at pleasure. This balancing-power is well seen in the Humming-bird, Humming-bird Moth †, and Wind-hover (Pl. XV. fig. 60), all of which can, by the rapid oscillation of their wings, and by the judicious management of the angle at which they

* In a lecture which I delivered at the Royal Institution of Great Britain "On the Various Modes of Flight in Relation to Aeronautics," I stated the angle at which the wing strikes the air during the downward stroke to be 45°. Recent examinations, however, induce me to believe that the one given above is relatively the more accurate. (Proceedings of the Royal Institution of Great Britain, March 1867.)

† The Humming-bird Moth (*Macroglossa stellatarum*) greatly resembles the true Humming-bird, not only in its appearance but habits, as it does not alight on the flower, but takes its food on the wing by hovering stationary in front and inserting into the nectary its long and taper trunk, which has just the appearance of a Humming-bird's beak.

cause them to strike, fix themselves, as it were, in the air*. It is also observable in the gyrations of the Eagle and Albatros (see Diagram), both of which modify the angle in such a manner as enables them to sail about for incredible periods, and to fly immense distances without apparently moving the wings at all. The wing, it appears to me, is applied to the air very much after the manner of a boy's kite—the angle in the kite being modified and determined by the stiffness of the breeze, and the length and weight of the string and tail. The pectoral fin of the Flyingfish affords a good illustration of its peculiar mode of action. In this anomalous and interesting creature the flying-fin or wing attacks the air *from beneath*, whilst it is being raised above the body†. It has no downward stroke, the position and attachments of the fin preventing it from descending beneath the level of the body of the fish. In this respect the flying-fin of the fish materially differs from the wing of the insect, bat, and bird. The gradual expansion and raising of the fins of the fish in almost the same plane during extension accounts for the admitted absence of beating, and has no doubt originated the belief that the pectoral fins are merely passive organs. If, however, they do not act as true pinions within the limits prescribed, it is difficult, and, indeed, impossible, to understand how such small creatures could obtain the momentum necessary to project them a distance of 200 or more yards, and to attain, as they sometimes do, an elevation of 20 or more feet above the water. Mr. Swainson, in crossing the line in 1816, zealously attempted to discover the true action of the fins in question; but the flight of the fish is so rapid that he utterly failed. He gives it as his opinion that flight is performed in two ways,—1st by a spring or leap, and 2nd by the spreading of the pectoral fins, which are employed in propelling the fish in a forward direction, either by flapping or by a motion analogous to the skimming of Swallows. He records the important fact that the Flyingfish can change its course after leaving the water, which satisfactorily proves that the fins are not simply passive structures. Mr. Lord, of the Royal Artillery‡, thus writes of those remarkable specimens of the finny tribe. "There is no sight more charming or pleasant to remember than the flight of a shoal of Flyingfish as they shoot forth from the dark-green wave in a glittering throng, like silver birds in some gay fairy tale, gleaming brightly in the sunshine, and then, with a mere touch on the crest of the heaving billow, again flitting onward reinvigorated and refreshed."

* This circumstance goes against the belief that the wing requires to operate upon fresh or undisturbed columns of air at each stroke to prove effective. Indeed the rapid division and reunion of the air renders this condition in a measure unnecessary. For explanation of the manner in which the wing acts in these cases *vide infrà*. Although the insect and bird can sustain themselves in the air by acting upon air previously agitated, I think it proper to observe that, in such instances, the muscular efforts required are incomparably greater than when fresh columns are operated upon, and when insect and bird are progressing at a high speed. In the latter case the momentum acquired by the body reduces the excessive expenditure of muscular action, the velocity attained securing additional support by not giving the particles of air acted upon time to escape or separate. For fuller exposition of this view *vide infrà*.

† In insects whose wings during the period of repose are raised vertically above their backs, as is the case in Butterflies, the wings are lowered and slewed round till they make an angle of 30°, or thereabouts, with the horizon, so that they act upon the air *from above*, as well as from beneath. The Butterfly, as well as insects generally, has therefore a down and an up stroke—the Flyingfish having only the latter. In the insect the stroke is delivered, as it were, at the proper angle, and the gliding upward follows, but so closely as to be almost simultaneous; whereas in the Flyingfish the stroke and the gliding upwards are synchronous.

‡ 'Nature and Art,' November 1866, p. 173.

Flight under water, &c.—In birds which fly indiscriminately above and beneath the water the wing is provided with stiffer feathers than usual, and reduced to a minimum as regards size. In subaqueous flight the wings may act by themselves, as in the Guillemots, or in conjunction with the feet, as in the Grebes*. To convert the wing into a powerful oar for swimming, it is only necessary to extend and flex it in a slightly backward direction, the mere act of extension causing the feathers to roll down, and giving to the back of the wing which communicates the effective stroke the angle or obliquity necessary for sending the animal forward. This angle, I may observe, corresponds with that made by the foot during extension, so that, if the feet and wings are both employed, they act in harmony. If proof were wanting that it is the back or convex surface of the wing which gives the effective stroke in subaquatic flight, it would be found in the fact that in the Penguin (Plate XII. fig. 5) and Great Auk, which are totally incapable of flying out of the water, the wing is actually twisted round (Plate XV. fig. 57*d*) in order that the concave surface, which takes a better hold of the water, may be directed backwards†. The thick margin of the wing when giving the effective stroke is, moreover, turned downwards (Plate XV. fig. 57*c*), as happens in the flippers of the Walrus, Otaria (Plate XV. fig. 51*c*), and Turtle (Plate XV. fig. 55*c*). This, I need scarcely remark, is precisely the reverse of what occurs in the ordinary wing in aerial flight. In those extraordinary birds (Great Auk and Penguin) the wing is covered with short, bristly-looking feathers, and is a mere rudiment and exceedingly rigid, the movement which wields it emanating from the shoulder, where the articulation partakes of the nature of a universal joint. The wing is beautifully twisted upon itself (Plate XV. fig. 57*c*,*d*), and during the act of extension rolls up from the side of the bird at varying degrees of obliquity till it makes a right angle with the body, when it presents a *narrow* or *cutting edge* to the water, the wing, when fully extended, as in ordinary flight, making, on the contrary, an angle of something like 30° with the horizon. A reverse movement takes place during flexion, when the effective or back stroke is made‡. The wing of the Penguin and Auk consequently acts very much after the manner of a screw; and this, as I shall endeavour to show, holds true likewise of the wing adapted for aerial flight§.

* The Guillemots in diving do not use their feet; so that they literally fly under the water. Their wings for this purpose are reduced to the smallest possible dimensions consistent with flight. The Loons, on the other hand, while they employ their feet, rarely, if ever, use their wings. The subaqueous progression of the Grebe resembles that of the Frog. (Cuvier's 'Animal Kingdom,' Lond. 1840, p. 252–3.)

† In the Crocodile, Turtle, Triton, and Frog the concave surfaces of the feet of the anterior extremities in swimming are likewise turned backwards.

‡ The effective stroke is also delivered during flexion in the Shrimp, Prawn, and Lobster.

§ For fuller exposition of this view see paper by the author, "On the Various Modes of Flight in relation to Aeronautics," Proceedings of the Royal Institution of Great Britain, March 22nd, 1867. Our countryman Sir George Cayley gave the first practical illustration of the efficacy of the screw as applied to the air, in 1796. In that year he constructed a small machine consisting of two screws made of quill feathers. The screws were each composed of four feathers stuck in a piece of cork, the corks being drilled in the centre to receive a driving shaft or axis. To the shaft a whalebone spring, with a string which coiled round the shaft (and by which the spring was wound up), was affixed. By turning the upper screw (the lower one being secured) a sufficient number of times, the proper degree of tension was conferred on the spring; and the instant the apparatus was liberated, it flew into the air. This interesting experiment is described at length, and the apparatus figured, in Nicholson's Journal for 1809, p. 175.

The rudimentary wings or paddles of the Penguin (the movements of which I had an opportunity of studying in a tame specimen) are principally employed in swimming and diving. The feet, which are of moderate size and strongly webbed, are occasionally used as auxiliaries. There is this difference between the movements of the wings and feet of this most curious bird, and it is worthy of attention. The wings are advanced together, or synchronously, as in flying birds; the feet, on the other hand, are moved alternately. The wings are wielded with great energy, and, because of their semirigid condition, are incapable of expansion. They therefore present their maximum and minimum of surface by a partial rotation or tilting of the pinion, as in the Walrus, Sea-Bear, and Turtle. The feet, which are moved with less vigour, are, on the contrary, rotated or tilted to a very slight extent, the increase and diminution of surface being secured by the opening and closing of the membranous expansion or web between the toes. In this latter respect they bear a certain analogy to the feet of the Seal, the toes of which, as has been explained, spread out or divaricate during extension, and the reverse. The feet of the Penguin entirely differ from those of the Seal in being worked separately, the foot of one side being flexed or drawn towards the body, while its fellow is being extended or pushed away from it. The feet, moreover, describe definite curves in opposite directions, the right foot proceeding from within outwards and from above downwards during extension, or when it is fully expanded and giving the effective stroke (Plate XV. fig. 57*x*), the left one, which is moving at the same time, proceeding from without inwards and from below upwards during flexion, or when it is folded up, as happens during the back stroke. In the acts of extension and flexion the legs are slightly rotated and the feet more or less tilted. The same movements are seen in the feet of the Swan (Plate XV. fig. 54) and in those of swimming birds generally. Each foot consequently describes an ellipse; and these being joined, as they necessarily must be, in motion, give separate spirals (Plate XV. fig. 77). There is consequently an obvious analogy between the movements of the fish (Plate XV. fig. 76), biped (Plate XV. fig. 78), quadruped, and bird (Diag. *infrà*); and similar remarks might be made with equal propriety regarding those of the reptile and insect.

Mr. Macgillivray thus describes a flock of Red Mergansers which he observed pursuing Sand-Eels in one of the shallow sandy bays of the Outer Hebrides:—"The birds seemed to move under the water with almost as much velocity as in the air, and often rose to breathe at a distance of 200 yards from the spot at which they had dived"*.

Cayley's idea has been taken up with great warmth of late years by Mons. Nadir, of Paris; and MM. Pontin d'Amécourt and De la Landelle have constructed, quite recently, helicopteric models driven by clockwork, which not only rise into the air of themselves, but carry a very considerable amount of cargo in the shape of graduated weights. The screws employed in the French models are remarkable for the great length and narrowness of their blades, it being found *ceteris paribus* that a greater degree of elevating-power is obtained from a long narrow blade, acting at a small angle with the horizon, than from a shorter and broader blade acting at a greater angle. This principle is fully explained in an ingenious paper read by Mr. Wenham before the Royal Aeronautical Society of Great Britain, "On Aerial Locomotion and the laws by which heavy bodies impelled through the air are sustained." *Vide* Annual Report of the Society for 1867.

* History of British Birds, vol. i. p. 48.

From what has been stated it will be evident that the wing acts very differently in and out of the water; and this is a point deserving of attention, the more especially as it seems to have hitherto escaped observation. In the water the wing strikes *downwards and backwards*, and acts as an auxiliary of the foot; whereas in the air it strikes *downwards and forwards*. The oblique surfaces, spiral or otherwise, presented by animals to the water and air are therefore made to act in opposite directions, as far as the down and up strokes are concerned. This is owing to the greater density of water as compared with the air,—the former supporting or nearly supporting the animal moving upon or in it, the latter permitting the creature to fall through it in a downward direction between the ascent and descent of the wing. To counteract the tendency of the bird in motion to fall in a downward and forward direction, the stroke is delivered in the direction in which falling would naturally occur, the kite-like action of the wing, and the rapidity with which it is moved causing the mass of the bird to pursue a more or less horizontal direction. I offer this explanation of the action of the wing in and out of the water after repeated and careful observation in tame and wild birds, and, as I am aware, in opposition to all previous writers on the subject*. The movement of the wing of the bird in true flight is fully explained at pages 224–227.

Before proceeding to a consideration of the graceful and, in some respects, mysterious evolutions of the denizens of the air, and the far-stretching pinions by which they are produced, it may not be out of place to say a few words in recapitulation regarding the extent and nature of the surfaces by which progression is secured on land and on or in the water. This is the more necessary, as the travelling-surfaces employed by animals in walking and swimming bear a certain, if not a fixed, relation to those employed by Bats, Insects, and Birds in flying. On looking back, we are at once struck with the fact, remarkable in some respects, that the travelling-surfaces, whether feet, flippers, fins, or pinions, are, as a rule, increased in proportion to the tenuity of the medium on which they are destined to operate. This is well seen in Plate XII., where the subjects are expressly arranged to illustrate the increase in question. In the Ox (fig. 1) we behold a ponderous body, slender extremities, and unusually small feet. The feet are slightly expanded in the Otter (fig. 2), and considerably so in the Ornithorhynchus (fig. 3). The travelling-area is augmented in the Seal (fig. 4), Penguin (fig. 5), Sea-Bear (fig. 6), and Turtle (fig. 7). In the Triton (fig. 8) a huge swimming-tail is added to the feet—the tail becoming larger, and the extremities (anterior) diminishing, in the Manatee (fig. 9) and Porpoise (fig. 10), until we arrive at the fish (fig. 11), where not only the tail but *the lower half of the body* is actively engaged in natation. Turning from the water to the air, we observe a remarkable modification in the huge pectoral fins of the Flyingfish (fig. 12), these enabling the creature to take enormous leaps, and serving as pseudo-pinions. Turning in like manner from the earth to the air, we encounter the immense tegumentary expansions of the Flying Dragon (Plate XIII. fig. 13) and Galeopithecus (Plate XIII.

* Mr. Macgillivray, in alluding to those birds which dive in pursuit of their prey, states that "they propel themselves under water by alternate motions of their feet, but also, and that more especially, by the synchronous action of the wings, which are used *precisely in the same manner as in aerial flight*."—*Op. cit.* vol. i. p. 48. For prevailing opinions as to the manner in which the wing acts in ordinary flight see foot-notes to p. 253.

fig. 18), the floating or buoying area of which greatly exceeds that of some of the flying beetles (Plate XIII. fig. 16).

In those animals which fly, as Bats (Plate XIII. fig. 15), Insects (Plate XIII. fig. 19), and Birds (Plate XIV.), the travelling-surfaces, because of the extreme tenuity of the air, are prodigiously augmented (in some instances exceeding the actual area of the body to an almost incomprehensible extent (Plate XIII. fig. 27). While, therefore, the movements involved in walking, swimming, and flying are to be traced in the first instance to the contraction and relaxation of the muscular, fibrous, or other contractile tissues, and to the bones, when present, and the peculiar forms of their articular surfaces, they are to be referred in the second instance to the extent and configuration of the travelling-areas—these on all occasions being accurately adapted to the capacity and strength of the animal and the density of the medium on or in which it is intended to progress. Thus the land supplies the resistance, and affords the support necessary to prevent the small feet of land-animals from sinking to dangerous depths, while the water, immensely less resisting, furnishes the peculiar medium requisite for buoying the fish, and for exposing, without danger and to most advantage, the vast extent of surface contained in its ponderous lashing tail,—the air, unseen and unfelt, furnishing that quickly yielding and subtle element on which the rushing pinions of the insect, bat, and bird vibrate with lightning rapidity, with never a grate, a jerk, or a jar.

PROGRESSION IN OR THROUGH THE AIR.

The atmosphere, because of its great tenuity, mobility, and comparative imponderability, presents little resistance to bodies passing through it at low velocities. If, however, the speed be greatly accelerated, the action of even an ordinary cane is sufficient to elicit a recoil.

This comes of the action and reaction of matter, the resistance experienced varying according to the density of the atmosphere and the shape, extent, and velocity of the body acting upon it. While, therefore, scarcely any impediment is offered to the progress of an animal in motion, it is often exceedingly difficult to compress the air with sufficient rapidity and energy to convert it into a suitable fulcrum for securing the onward impetus. This arises from the fact that bodies moving in this medium experience the *minimum of resistance* and occasion the *maximum of displacement*. Another and very obvious difficulty is traceable to the great disparity in the weight of air as compared with any known solid (this in the case of water being nearly as 1000 to 1), and the consequent want of buoying- or sustaining-power which that disparity involves. To meet these peculiarities the insect, bat, and bird are furnished with extensive surfaces in the shape of pinions or wings, which they can apply with singular velocity and power, as levers of the third order*, at various angles, or by alternate slow and sudden movements, to obtain the necessary degree of resistance and non-resistance. Although the third order of lever is particularly

* In this form of lever, as every one knows, the power is applied between the fulcrum and the weight to be raised. The mass to be elevated in the present instance is, I need scarcely remark, the body of the insect, bat, or bird,—the force which resides in the living pinion (aided by the inertia of the trunk) representing the power, and the thin medium of the air the fulcrum.

inefficient when the fulcrum is *rigid* and *immobile*, it possesses singular advantages when these conditions are reversed, *i. e.* when the fulcrum, as happens with the air, is *elastic* and *yielding*. In this instance a very slight movement at the root of the pinion, or that end of the lever directed towards the body, is followed by an immense sweep of the extremity of the wing, where its elevating and propelling power is greatest,—this arrangement ensuring that the large quantity of air necessary for propulsion and support shall be compressed under the most favourable conditions. In this process the weight of the body performs an important part, by acting upon the inclined planes formed by the wings in the direction of the plane of progression. The power and the weight may thus be said to reciprocate, the two sitting, as it were, side by side, and blending their peculiar influences to produce a common result. From the mechanical principles on which all wings are constructed it follows that those insects and birds are endowed with the greatest powers of flight whose wings are the longest. The Dragon Fly and Albatros furnish illustrative examples, the former on some occasions dashing along with amazing velocity and wheeling with incredible rapidity; at other times it suddenly checks its headlong career and hovers or fixes itself in the air after the manner of the Kestrel (Plate XV. fig. 60) and Humming-birds: the flight of the Albatros is also remarkable, this magnificent bird, I am informed on reliable authority, sailing about with apparent unconcern for hours together, and rarely deigning to flap its enormous pinions, which stream from its body like ribands to the extent, in some cases, of 7 feet on either side.

Air-cells and -sacs in Insects and Birds.—The bodies of insects, bats, and birds are constructed on strictly mechanical principles,—lightness, strength, and durability of frame, and power, rapidity, and precision of action being indispensable. The cylindrical method of construction is consequently carried to an extreme, the bodies and legs of insects displaying numerous unoccupied spaces, while the muscles and solid parts are tunnelled in every direction by innumerable air-tubes, which communicate with the surrounding medium by a series of apertures termed spiracles.

A somewhat similar disposition of parts is met with in birds, these being in many cases furnished not only with hollow bones, but also (especially the aquatic ones) with a liberal supply of air-sacs. They are likewise provided with a dense covering of feathers or down, which adds greatly to their bulk without materially increasing their weight. Their bodies, moreover, in not a few instances, particularly in birds of prey, are more or less flattened. The air-sacs are well seen in the Swan, Goose, and Duck; and I have on several occasions minutely examined them with a view to determine their extent and function. In two of the specimens which I injected, the material employed had found its way not only into those usually described, but also into others which ramify in the substance of the muscles, particularly the pectorals. Whether, however, this was due to rupture and extravasation I have not since had an opportunity of ascertaining. No satisfactory explanation of the purpose served by these air-sacs has, I regret to say, been yet tendered. According to Sappey*, who has devoted a large share of attention to the subject, they consist of a membrane

* Sappey enumerates fifteen air-sacs:—the *thoracic*, situated at the lower part of the neck, behind the sternum; *two cervical*, which run the whole length of the neck to the head, which they supply with air; *two pairs of anterior*, and *two pairs of posterior diaphragmatic*; and *two pairs of abdominal*. The subjoined remarks occur in his large

which is neither serous nor mucous, but partly the one and partly the other; and as blood-vessels in considerable numbers, as my preparations show, ramify in their substance, and they are in many cases covered with muscular fibres which confer on them a rhythmic movement, some recent observers (Mr. Drosier*, of Cambridge, for example) have endeavoured to prove that they are adjuncts of the lungs, and therefore assist in aerating the blood. This opinion was advocated by John Hunter as early as 1774†, and is probably correct, since the temperature of birds is higher than that of any other class of animals, and because they are obliged to make great muscular exertions both in swimming and flying. Others have viewed the air-sacs in connexion with the hollow bones frequently, though not always, found in birds‡, and have come to look upon the heated air which they contain as being more or less essential to flight§. That they have absolutely nothing to do with this function is proved by the fact that some excellent fliers (take the Bats *e. g.*) are destitute of them, while birds such as the Ostrich and Apteryx, which are incapable

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work on the subject:—"The air-sacs are neither serous nor mucous, but they are more allied to the former. They are very slightly vascular, and the vessels are long and slender, and do not arise from the pulmonary artery and veins, as those who regard the air-sacs as expansions of the mucous membrane of the lungs or adjuncts of respiration believe. On the contrary the arteries arise from the aortic system, and the veins run directly or indirectly into the venæ cavæ. Sometimes the arteries and veins run side by side, and sometimes separately. The air-sacs are in some instances provided with a fibrous envelope, which invests them more or less completely, the envelope possessing remarkable elastic properties which manifest themselves more especially when the sacs cannot be acted upon by the true muscular system. The bird is furnished with a double diaphragm; and the sacs are emptied and filled alternately, so that there is a double respiratory process going on."—*Researches on the Respiratory Apparatus, by Ph. C. Sappey*: Paris 1847. Sappey found no lymphatics, although he looked carefully for them both in the living and the dead bird.

* "On the Functions of the Air-cells and the Mechanism of Respiration in Birds, by W. H. Drosier, M.D., Caius College," Proc. Camb. Phil. Soc. Feb. 12, 1866.

† "An account of certain receptacles of air in birds, which communicate with the lungs, and are lodged among the fleshy parts and in the hollow bones of these animals," Phil. Trans., Lond. 1774.

‡ According to Dr. Crisp the Swallow, Martin, Snipe, and many birds of passage have no air in their bones (Proc. Zool. Soc. Lond. part. xxv. 1857, p. 13). The same author, in a second communication (pp. 215 and 216), adds that the Glossy Starling, Spotted Flycatcher, Whin-Chat, Wood-Wren, Willow-Wren, Black-headed Bunting, and Canary, five of which are birds of passage, have likewise no air in their bones. The following is Dr. Crisp's summary:—Out of 92 birds examined he found:—"air in many of the bones, 5 (Falconidæ); air in the humeri and not in the inferior extremities, 39; no air in the extremities and probably none in the other bones, 48."

§ "The power which birds enjoy of raising and supporting themselves in the air is aided by the lightness of the body. The large and usually air-filled cavities in the bones diminish their weight without taking away from their strength, a hollow cylinder being stronger than a solid one of the same weight and length. But the specific levity principally depends on the great air-cells which occupy almost every part of the body. The air which birds inspire distends these cells, and is rarefied by the heat of the body."—*Comp. Anat. and Phys. of Vertebrates, by Prof. Owen*, vol. ii. p. 114.

Dr. Bennett states "that the whole surface of the body of the Albatros is covered by numerous air-cells capable of a voluntary inflation or diminution by means of a beautiful muscular apparatus. . . . . By this power the birds can raise or depress themselves at will." For refutation of this view see paper by Captain F. W. Hutton, "On some of the Birds inhabiting the Southern Ocean," Ibis, 2nd series, vol. i. 1865 (p. 294–5). This gentleman calculates that, to raise an Albatros of 17 lbs. weight by means of heated air, the sacs would require to contain 1820 cubic feet, which would occupy a sphere of more than 15 feet in diameter. "If," he adds, "the heated air did succeed in raising the Albatros, the object in view would be defeated, as the bird, being lighter than the air, would drift helplessly to leeward."

of flight, are provided with them. Analogous air-sacs, moreover, are met with in animals never intended to fly; and of these I may instance the great air-sac occupying the cervical and axillary regions of the Orang-outang, the float or swimming-bladder in fishes, and the pouch communicating with the trachea of the Emu*.

The same may be said of the hollow bones,—some really admirable fliers, as the Swifts, Martins, and Snipes, having their bones filled with medullary substance, while those of the wingless running birds alluded to have air. Furthermore and finally, a living bird weighing 10 lbs. weighs the same when dead, plus a very few grains; and all know what effect a few grains of heated air would have in raising a weight of 10 lbs. from the ground.

When we have said that cylinders and hollow chambers increase the area of the insect and bird, and that an insect and bird so constructed is stronger, weight for weight, than one composed of solid matter, we may dismiss the subject, flight being, as I shall endeavour to show by-and-by, not so much one of levity as of weight and power properly directed, *i. e.* weight and power directed on strictly mechanical principles. Those who subscribe to the heated-air theory are of opinion that the air contained in the cavities of insects and birds is so much lighter than the surrounding atmosphere, that it must of necessity contribute materially to flight. I may mention, however, that the quantity of air imprisoned is, to begin with, so infinitesimally small, and the difference in weight which it experiences by increase of temperature so inappreciable, that it ought not to be taken into account by any one endeavouring to solve the difficult and important problem of flight. The Montgolfier or fire-balloons were constructed on the heated-air principle; but as these have no analogue in nature, and are apparently incapable of improvement, they are mentioned here rather to expose what I regard as a false theory, than as tending to elucidate the true principles of flight.

Weight indispensable in Flight.—The area of the insect and bird, when the wings are fully expanded, is, with the single exception of the Bats, greater than that of any other class, their weight being proportionally less. It ought, however, never to be forgotten that even the lightest insect or bird is immeasurably heavier than the air, and that there is no fixed relation existing between the weight of body and the expanse of wing in either order. We have thus light-bodied and large-winged insects and birds—as the Butterfly (Plate XIII. fig. 27), Heron (Plate XIV. fig. 38), and Albatros,—and others whose bodies are comparatively heavy, while their wings are insignificantly small—as the Sphinx Moth (Plate XIII. fig. 19) and Centaur Beetle (Plate XIII. fig. 16) among insects, and the Grebe, Quail, and Partridge (Plate XIV. fig. 32) among birds. Those apparent inconsistencies in the dimensions of the body and wing are readily explained by the greater muscular development of the heavy-bodied short-winged insects and birds, and the increased power and rapidity with which

* Nearly allied to this is the great gular pouch of the Bustard. Specimens of the air-sac in the Orang, Emu, and Bustard, and likewise of the air-sacs of the Swan and Goose, as prepared by me, may be seen in the Museum of the Royal College of Surgeons of England. The air-sac of the Orang has been figured and described by Sandifort in the 'Verhandelingen over de Natuurlyke Geschiedenis der Nederlandsche overseesche Bezittingen,' Leiden, 1840; that of the Emu by Murie, P. Z. S. 1867, p. 405; that of the Bustard by Newton and Cullen, 'Ibis,' 1862, p. 107, and 1865, p. 143—and also by Flower, P. Z. S. 1865, p. 747.

the wing in them is made to oscillate. This is of the utmost importance in the science of aerostation, as showing that flight may be attained by a heavy powerful animal with comparatively short wings, as well as by a lighter one with enormously enlarged wings. While, therefore, there is apparently no correspondence between the area of the wing and the animal to be raised, there is, unless in the case of sailing birds*, an unvarying relation as to the weight and number of oscillations; so that the problem of flight would seem to resolve itself into one of weight, power, velocity, and small surfaces, *versus* buoyancy, debility, diminished speed, and extensive surfaces,—weight in either case being a *sine quâ non*. In order to utilize the air as a means of transit, the body in motion, whether it moves in virtue of the life it possesses, or because of a force superadded, must be heavier than it. It must tread and rise upon the air as a swimmer upon the water, or as a kite upon the wind. This is necessary for the simple reason that the body must be active, the air passive. It must act against gravity, and elevate and carry itself forward at the expense of the air and of the force which resides in it, whatever that may be. If it were otherwise—if it were rescued from the law of gravity on the one hand, and bereft of independent movement on the other, it would float about uncontrolled and uncontrollable, as happens in the ordinary gas-balloon.

The difference between an insect or a bird and a balloon, here insisted upon, was, I have learned since writing the above, likewise adverted to by His Grace the Duke of Argyle in his very able and eloquent article in 'Good Words,' entitled "The Reign of Law"†.

Wing-area variable and in excess.—That no fixed relation exists between the area of the wings and the size and weight of the body is evident on comparing the dimensions of the wings and bodies of the several orders of insects, bats, and birds. If such comparison be made, it will be found that the pinions in some instances diminish while the bodies increase, and the reverse. No practical good can therefore accrue to aerostation from elaborate measurements of the wings and trunks of any flying thing; neither can any rule be laid down as to the extent of surface required for sustaining a given weight in the air. The statements here advanced are borne out by the fact that the wings of insects, bats, and birds may be materially reduced without impairing their powers of flight. This is notably the case in the common Blow-fly, as the following experiments instituted by me in August 1866 will conclusively show. In the clear sunny mornings of that month I caught a number of the insects in question, on the leaves of a vine-tree, in such a manner as not to injure them in the least. I operated upon their pinions with sharp-pointed scissors, with the following results:—

Experiment 1. Detached posterior or thin half of either wing in its long axis. Flight perfect.

* In birds which skim, sail, or glide, the pinion is greatly elongated or ribbon-shaped (Plate XV. fig. 64), and the weight of the body is made to operate upon the inclined planes formed by the wings, in such a manner that the bird when it has once got fairly under weigh, is in a measure self-supporting. This is especially the case when it is proceeding against a slight breeze—the wind and the inclined planes resulting from the upward inclination of the wings reacting upon each other, with this very remarkable result, that the mass of the bird moves steadily forwards in a more or less horizontal direction.

† 'Good Words' for February 1865. This paper, I am glad to find, has been reprinted in a separate and extended form with numerous illustrations, and should be consulted by all interested in the subject of Aeronautics.

Exp. 2. Detached posterior *two-thirds* of either wing in its long axis. Flight still perfect. I confess I was not prepared for this result.

Exp. 3. Detached one-third of anterior or thick margin of either pinion obliquely. Flight imperfect.

Exp. 4. Detached one-half of anterior or thick margin of either pinion obliquely. The power of flight completely destroyed. From experiments 3 and 4 it would seem that the anterior margin of the wing, which contains the principal nervures, and which is the most rigid portion of the pinion, cannot be mutilated with impunity.

Exp. 5. Detached one-third from the extremity of either wing transversely, *i. e.* in the direction of the short axis of the pinion. Flight perfect.

Exp. 6. Detached *one-half* of either wing transversely, as in experiment 5. Flight very slightly (if at all) impaired.

Exp. 7. Divided either pinion in the direction of its long axis into three equal parts, the anterior nervures being contained in the anterior portion. Flight perfect.

Exp. 8. Notched two-thirds of either pinion obliquely from behind. Flight perfect.

Exp. 9. Notched anterior third of either pinion transversely. The power of flight destroyed. Here, again, the mutilation of the anterior margin was followed by loss of function.

Exp. 10. Detached posterior two-thirds of right wing in its long axis, the left wing being untouched. Flight perfect. I expected that this experiment would result in loss of balancing-power; but this was not the case.

Exp. 11. Detached half of right wing transversely, the left one being normal. The insect flew irregularly, and came to the ground about a yard from where I stood. I seized it and detached the corresponding half of the left wing, after which it flew away as in experiment 6.

I performed a series of analogous and not less remarkable experiments on the wings of the Dragonfly.

Very similar results were likewise obtained from the House-sparrow, which is a heavy bird, and by no means a powerful flier :—

Exp. 12. Detached the half of the secondary feathers of either pinion in the direction of the long axis of the wing, the primaries being left intact. Flight as perfect as before the mutilation took place. In this, as in many of the subsequent experiments, one wing was operated upon before the other, in order to test the balancing-power. In the present case the bird flew perfectly, either with one or with both wings cut.

Exp. 13. Detached the half of the secondary feathers and a fourth of the primary ones of either pinion in the long axis of the wing. Flight in no wise impaired. The bird, in this instance, flew upwards of 30 yards, and, having risen a considerable height, dropped into a neighbouring tree.

Exp. 14. Detached nearly the half of the primary feathers in the long axis of either pinion, the secondaries being left intact. When one wing only was operated upon, flight was perfect; when both were tampered with, it was still perfect, but slightly laboured.

Exp. 15. Detached rather more than a third of both primary and secondary feathers of

either pinion in the long axis of the wing. In this case the bird flew with evident exertion, but was able, notwithstanding, to attain a very considerable altitude.

From experiments 12, 13, 14, and 15, as well as from experiments 1 and 2, it would appear that great liberties may be taken with the posterior or thin margin of the wing, and the dimensions of the wing in this direction materially reduced, without destroying, or even vitiating in a marked degree, the powers of flight. This is no doubt owing to the fact indicated by Sir George Cayley, and fully explained by Mr. Wenham, that in all wings, particularly long narrow ones, the elevating-power is transferred to the anterior or front margin. (See footnote to p. 258.)

Exp. 16. Removed alternate primary and secondary feathers from either wing, beginning with the first primary. The bird flew upwards of 50 yards with very slight effort, rose above an adjoining fence, and wheeled over it a second time to settle on a tree in the vicinity. When one wing only was operated upon, it flew irregularly or lopsided.

Exp. 17. Removed alternate primary and secondary feathers from either wing, beginning with the *second primary*. Flight, from all I could determine, perfect. When one wing only was cut, flight was irregular or lopsided, as in 16.

From experiments 16 and 17, as well as experiments 7 and 8, it would seem that the wing does not of necessity require to present an unbroken or continuous surface to the air, such as is witnessed in the pinion of the Bat, and that the feathers, when present, may be separated from each other without destroying the utility of the pinion. In the Raven and many other birds the extremities of the first four or five primaries divaricate in a marked manner (Plate XIV. figs. 41 and 43). A similar condition is met with in the *Alucita hexadactyla* (Plate XIII. fig. 14), where the delicate feathery-looking processes composing the wing are widely removed from each other. The wing, however, *ceteris paribus*, is strongest when the feathers are not separated from each other, and when they *overlap*, as then they are arranged so as mutually to support each other.

Exp. 18. Removed half of the primary feathers from either wing transversely, *i. e.* in the direction of the short axis of the wing. Flight very slightly, if at all, impaired when only one wing was operated upon. When both were cut the bird flew heavily, and came to the ground at no very great distance. This mutilation was not followed by the same result in experiments 6 and 11. On the whole, I am inclined to believe that the area of the wing can be curtailed with least injury in the direction of the long axis of the pinion.

Exp. 19. The carpal or wrist-joint of either pinion rendered immobile by lashing the wing to a slender reed, the elbow-joint being left free. The bird, on leaving the hand, fluttered its wings vigorously, but after a brief flight came heavily to the ground, thus showing that a certain degree of twisting and folding, or flexing of the wing, is necessary to flight, and that, however the superficies and shape of the pinion may be altered, the movements thereof must not be interfered with. I tied up the wings of a Pigeon in the same manner, with a precisely similar result. (See p. 253.)

The birds operated upon were, I may observe, caught in a net, and the experiments made within a few minutes from the time of capture.

The inference to be deduced from the foregoing observations and experiments is plainly this, that even in *large-bodied, small-winged* insects and birds, the wing-surface is greatly in excess, the surplus wing-area supplying that degree of sustaining- or elevating-power which is necessary to prevent undue exertion on the part of the animal. In this we have a partial explanation of the buoyancy of insects, and the great lifting-power possessed by bats and birds—the bats carrying their young without inconvenience, the birds elevating surprising quantities of fish, game, carrion, &c.

The movements of the wings in insects, bats, and birds are essentially the same. It is otherwise with the structure of the wings, the wing of the insect being in some respects rudimentary as compared with that of the bat and bird. The pinion in either case is to be regarded as a living, delicately-organized structure, whose parts and proportions are adjusted with mathematical accuracy to the strength of the animal and the rapidity of the vibrations necessary to raise its weight from the ground. The wing, as a rule, is more or less triangular in shape (Plate XV. figs. 63, 65, and 66), the base of the triangle being directed towards the body, the sides anteriorly and posteriorly. It is also conical in section from within outwards and from before backwards, this shape converting the pinion into a delicately graduated instrument, balanced with the utmost nicety, to satisfy the requirements of the muscular system on the one hand and the resistance and resiliency of the air on the other. Those conditions are necessary to correct the unequal strain to which the different portions of the wing are exposed in action, as well as to prevent shock to the system. While all wings are graduated as explained, innumerable varieties occur as to their general contour, some being falcated or scythe-like, others oblong, others rounded or circular, some lanceolate, and some linear. Thus far a parallelism may be established between the wing of the insect, bat, and bird; but when we come to speak of the margins of the pinion, we find the wings of bats and birds present little variety, whereas those of insects may be crenated, dentated, ciliated, fimbriated, digitated, or caudated. Still greater differences occur as to surfaces, the wings of bats and birds presenting a uniform appearance, those of insects being hairy, naked, farinose, scaly, veined, reticulated, and striated, as happens.

THE WINGS OF INSECTS.

Elytra or wing-cases—their shape and uses.—The wings of insects may consist either of one (Plate XIII. fig. 20) or two (Plate XIII. fig. 24) pairs,—the anterior or upper pair, when two are present, being in some instances greatly modified and presenting a corneous condition (Plate XIII. fig. 16 *r*). When so modified, they cover the under wings (*e*) when the insect is reposing, and have from this circumstance been named elytra, from the Greek ἔλυτρον, a sheath. The elytra, or wing-cases, as they are sometimes called, are dense, rigid, and opaque in the beetles (Plate XIII. fig. 16 *r*), solid in one part and membranaceous in another in the cockroaches (Plate XIII. fig. 21 *r*), more or less membranous throughout in the grasshoppers, and completely membranous in the dragonflies (Plate XIII. fig. 24 *e*). The elytra, otherwise known as the superior or upper wings, are inclined at a certain angle when extended, and are indirectly connected with flight in the beetles, cockroaches, and grasshoppers. They are actively engaged in this function in the dragonflies and butterflies. The elytra or anterior wings

are frequently employed as *sustainers* or *gliders* in flight, the posterior or true wings acting more particularly as *elevators* and *propellers*. In such cases the elytra are twisted upon themselves after the manner of wings (Plate XV. fig. 73), the anterior margin of the wing-case towards its root, or where it joins the body, being bent *downwards* and *forwards*, while towards its extremity it is bent *upwards* and *backwards*. The anterior margin consequently presents two curves, the convexity of the curve nearest the body being directed downwards and forwards, the convexity of that furthest away from the body being, on the contrary, directed upwards and backwards. Similar but reverse curves are found on the posterior margin; so that the air which is caught by the concavity occurring *towards* the *extremity* of the wing-case anteriorly is prevented from escaping *towards the root* of the wing-case in a forward direction by the elytra in this situation, as has been explained, being bent downwards and forwards. It is therefore compelled to pursue a spiral, oblique, and backward course along the under surface of the wing-case, until it arrives at the root of the wing-case posteriorly, where it is liberated.

The curves observed on the anterior and posterior margins of the wing-case are essentially the same as those met with in corresponding positions in the wing of the bird. (See pp. 242, 243, and 244.)

The Inferior or Membranous Wings—their twisted Form, Nervures, Function, &c.—The true wings of insects (and by this I mean the inferior or under membranous ones) present different degrees of opacity—those of the moths and butterflies being non-transparent (Plate XIII. figs. 19 and 27), those of the dragonflies (Plate XIII. fig. 24), bees, and common flies (Plate XIII. fig. 20) presenting a delicate, filmy, gossamer-like appearance. Both pairs of wings have this feature in common, and it is fundamental: they are composed of a duplicature of the integument or investing membrane, and are strengthened in various directions by a system of hollow, horny tubes, known to entomologists as the neuræ or nervures (Plate XIII. fig. 17 *d*, *e*, *f*, *n n n*; Plate XV. fig. 65 *d*, *e*, *f*, *c*, *a*, *b*). These nervures taper towards the extremity of the wing, and are strongest towards its root and anterior margin, where they supply the place of the arm in bats (Plate XIII. fig. 15 *r*, *d*, *e*, *f*) and birds (Plate XIV. fig. 29 *d'*, *e'*, *f'*). They are variously arranged. In the beetles they pursue a somewhat longitudinal course, and are jointed (Plate XV. fig. 65 *e*) to admit of the wing being folded up transversely beneath the elytra*. In the locusts (Plate XIII. fig. 23 *a*, *b*) they diverge from a common centre after the manner of a fan, so that by their aid the wing is crushed up or expanded as required; whilst in the dragonfly, where no folding is requisite, they form an exquisitely reticulated structure (Plate XIII. fig. 24 *e*, *f*). The neuræ, it may be remarked, are strongest in the beetles (Plate XIII. fig. 17 *d*, *e*, *f*), where the body is heavy and the wing small. They decrease in thickness as those conditions are reversed (Plate XIII. figs. 24 and 27), and entirely disappear in the minute Chalcis and Psilus†. The function of the neuræ is not ascertained; but as they contain spiral vessels which apparently communicate with the

* The wings of the May-fly are folded transversely and longitudinally as well, so that they are crumpled up into little squares.

† Kirby and Spence, vol. ii. 5th ed. p. 352.

tracheæ of the trunk, some have regarded them as being connected with the respiratory system, whilst others have looked upon them as the receptacles of a subtle fluid, which the insect can introduce and withdraw at pleasure to obtain the requisite degree of expansion and tension in the wing. Neither hypothesis is satisfactory, as respiration and flight can be performed in their absence. They appear to me, when present, rather to act as mechanical stays or stretchers, in virtue of their rigidity and elasticity alone,—their arrangement being such that they admit of the wing being folded in various directions, if necessary, during flexion, and give it the requisite degree of firmness during extension. They are, therefore, in every respect analogous to the skeleton of the wing in the bat and bird. In those wings which, during the period of repose, are folded up beneath the elytra, the mere extension of the wing in the dead insect, where no injection of fluid can occur, causes the nervures to fall into position, and the membranous portions of the wing to unfurl or roll out precisely as in the living insect, and as happens in the bat and bird. This result is obtained by the arrangement of the neuræ at the axis of the wing, the anterior one occupying a higher position than that further back, as in the leaves of a fan. The spiral arrangement occurring at the axis extends also to the margins, so that wings which fold up or close, as well as those which do not, are twisted upon themselves, and present a certain degree of convexity in the one direction and concavity in the other,—their free edges supplying those fine curves which act with such efficacy upon the air in obtaining the maximum of resistance and the minimum of displacement. As illustrative examples of the form of wing alluded to, those of the Sphinx Moth (Plate XIII. fig. 19), Beetle (Plate XIII. fig. 16 *e*), and Fly (Plate XIII. fig. 20) may be cited,—the pinions in those insects acting as helices or twisted levers (Plate XV. fig. 68), and elevating weights much greater than the area of the wing would seem to warrant. The insects adverted to fly, as a rule, with great accuracy and speed, and frequently in a straight line. The twisting of the wing upon itself before and during its action, to which I have directed attention, occurs also in the wing of the bat (Plate XV. fig. 69) and bird (Plate XV. fig. 70), and has not, so far as I am aware, been adverted to in any of the existing treatises on flight. It is occasioned in the bat and bird by the spiral configuration of the articular surfaces of the bones of the wing, and by the rotation of the bones of the arm, forearm, and hand upon their long axes. In the insect it is due to the conformation of the shoulder-joint, this being furnished with a system of check-ligaments, and with horny prominences or stops, set, as nearly as may be, at right angles to each other, and fashioned so as to necessitate the wing acting in the manner specified. The view here promulgated is discussed at length, when describing the wing of the bird, at pages 240–251 inclusive, and is calculated, it appears to me, to throw additional light on the theory and practice of flight. The twisting is least marked in those insects and birds whose wings are large as compared with their bodies. The butterfly may be cited as an example. Here the wings are unusually ample and, as a consequence, unusually flattened (Plate XIII. fig. 27). The flat form of wing, however, is not calculated to act with velocity and precision or to impress the air favourably. In other words, it does not respond to the rotation which occurs in all wings during flexion and extension to the same extent as the more twisted form, and as a result it smites the air clumsily—a circumstance which, taken in

connexion with the small body of the insect, fully explains the faltering, irregular course described by the order in their flight.

The threefold Action of the Wing in Insects &c.—The wing in the insect, as has been stated, is more flattened than in the bird; and advantage is taken on some occasions of this circumstance, particularly in heavy-bodied, small-winged, quick-flying insects, to reverse the pinion completely during the down and up strokes,—the wing, during its descent, having its anterior or thick margin inclined *upwards* and *backwards*, whereas, during its ascent, the anterior or thick margin is inclined *downwards* and *forwards*. The object of this arrangement is to increase the *elevating*-power, while it does not necessarily impair the *propelling*-power. This is effected in the following manner:—The posterior margin of the wing is made to rotate, during the down stroke, in a direction *from above downwards* and *from behind forwards*,—the anterior margin travelling in an opposite direction and reciprocating. The wing may thus be said to attack the air by a screwing movement *from above*. During the up or return stroke, on the other hand, the posterior margin rotates in a direction *from below upwards* and *from before backwards*, so that by a similar but reverse screwing motion, the pinion attacks the air *from beneath*. It may likewise happen, though more rarely, that the anterior or thick margin of the pinion may be directed *upwards* and *forwards* during the return or up stroke. I infer this from having observed that the anterior margin of the wing of the Wasp (when the insect is fixed and the wings are being driven briskly) is not unfrequently directed upwards and *backwards* at the beginning of the down stroke and upwards and *forwards* at the commencement of the up or return stroke. A figure of 8, compressed laterally and placed obliquely with its long axis running from left to right of the spectator, represents the movements in question. The down and up strokes, as will be seen from this account, cross each other, the wing smiting the air during its descent, *from above*, as in the bird and bat, and during its ascent, *from below*, as in the Flyingfish and boy's kite. The pinion thus acts as a *helix* or screw in a *more or less horizontal direction*, *from behind forwards* and *from before backwards*; but it has a third function, and it is to this I would more especially direct attention. It likewise acts as a screw in a *nearly vertical direction from below upwards*. It is to the upward screwing, or third function, that the wing of the insect owes its great elevating-power; and to this, in all probability, the almost perpendicular ascent of the lark is likewise due. The threefold action of the insect's wing is well seen in the Humble-Bee and Hornet; and if it were possible to make a longitudinal section of the blur made by the rapidly oscillating wings of the latter insect (examine blur as represented at *a a'* of figures 58 and 59, Plate XV.), it would be found to present the form of a truncated cone—the upper or narrow portion of the cone displaying a concave surface, the lower or broad part a convex one. The threefold action of the wing is more perceptible in the wing of the insect than in those of the bird and bat; and this is most probably due to the fact that the wing of the insect, with few exceptions, is *in one piece*, the maximum and minimum of surface being secured by a simple rotation of the pinion on its long axis; whereas in the bird and bat it is *in several pieces*, the pinion, in addition to being rotated on its long axis, having its area more or less *increased* in extension and *decreased*

in flexion. The upward and downward screwing of the anterior margin of the wing, and the increase and diminution of its area in extension and flexion, in the bird, is represented at fig. 29 of Plate XIV. In the figure referred to, the wing to the left of the observer is fully extended and ready to give the effective or down stroke, the anterior border (*d′ e′ f′*) and the under surface of the pinion being inclined obliquely *upwards* and *backwards* (see arrow). The wing to the right of the observer is, on the contrary, fully flexed and ready to make the return or up stroke, the anterior border (*e, f*) and under surface of the pinion being inclined obliquely *downwards* and *forwards* (*vide* arrow). The wing consequently rotates on its long axis in opposite directions during extension and flexion, *i. e.* during its descent and ascent; and if the rotation be conducted sufficiently far, it acts as an *elevator* in both directions, *propulsion* being performed almost exclusively by the more vigorous play of the pinion during its descent. The wing may act as an elevator when rotation is performed in a minor degree in quite another manner, as explained at p. 257.

The position of the wings during repose, as well as their condition, varies, the wings in one case being folded transversely and arranged on the back in a more or less longitudinal direction (Plate XIII. fig. 16 *e*); in another they are folded both longitudinally and transversely, as in the May-fly; whilst in a third they are crushed together like a fan (Plate XIII. fig. 23 *a*, *b*). When not folded, they may be raised vertically above the body (Plate XIII. fig. 26 *a*, *a′*), or slightly lowered or extended horizontally (Plate XIII. figs. 20 and 24), or inclined downwards, as in a roof of a house (Plate XIII. fig. 25).

Direction of the Down and Up Strokes in Flight, Centre of Gravity, &c.—From the foregoing account it is evident that the wings of insects vary as regards their number, size, and shape. They also differ as regards their surfaces, margins, venation, degree of consistence, and position; so that it might naturally be asked, Do the several orders of wings act according to a common principle, or does each wing act according to a principle of its own? There can be, I think, but one answer to this question. All wings obtain their leverage by presenting oblique surfaces to the air, the degree of obliquity gradually increasing during extension, when the sudden or effective stroke is being given, and gradually decreasing in an opposite direction during flexion, or when the wing is being more slowly recovered preparatory to making a second stroke. As the wing of the insect does not bend in a direction from before backwards, and from without inwards, during flexion, as happens in the bird and bat, the terms extension and flexion, when applied to it, are used in an arbitrary sense,—extension signifying the carrying of the wing in a forward direction away from the body, flexion meaning the reverse, or the drawing of the wing from before backwards towards the body. The effective stroke in insects (and this holds true also of bats and birds, *vide* pp. 255 and 256) is delivered *downwards* and *forwards*, and not, as is commonly believed, *vertically*, or even *slightly backwards* *. This arises from the curious circumstance that insects, bats, and birds, when flying, actually fall through the medium which elevates them, their course being indicated by the resultant of two forces, viz. that of gravity pulling vertically downwards, and that of the wing act-

* For prevailing opinions as to the direction of the effective or down stroke in birds, see footnotes to p. 255.

ing at a given angle in an upward direction. In those birds, insects, and bats which flap the wings leisurely, the stroke is delivered in an almost perpendicular direction, the wing, by rotating on its axis from behind forwards, causing the under surface of the pinion to act upon the air obliquely *from above downwards* and from *behind forwards*. The down stroke in slow-flying creatures is delivered nearly at right angles to the body, which is inclined in a slightly upward direction. The upward inclination of the body, and the comparative perpendicularity of the stroke, is necessary to counteract the tendency of the slow-flying animals to fall *vertically downwards*. In those insects, bats, and birds, however, whose wings are moved with great celerity and the speed attained is high, the down stroke is inclined *very decidedly forwards*—the tendency of the body to fall *downwards and forwards* increasing as the speed of the wing and the velocity of flight is augmented. The forward movement of the wing during the down or effective stroke is particularly evident in birds when rising, the wing, on such occasions, being urged with unusual vigour. The forward movement of the wing during the down stroke is singularly well seen in young Pigeons when thrown from the hand for the first time; and I have also noticed it in the Cormorant when leaving the water—this bird, because of its great weight, rising with considerable difficulty. The forward movement of the wing during its descent is also seen to advantage in the flight of the wild Goose and Duck, both of which fly with immense velocity. It can be increased and diminished at pleasure, and assists in regulating the rapidity of flight. The wing, in slow-flying insects, bats, and birds (Plate XIV. fig. 38), supports the centre of gravity by playing, as it were, alternately above and beneath it; whereas in those of rapid flight the pinion plays obliquely on either side of it, as shown in figures 58, 59, and 61, Plate XV. The sustaining area of the wings is greatly increased in birds, insects, and bats of rapid flight; and this is owing partly to the oblique direction of the stroke, and partly to the fact that the quickly vibrating wing, practically speaking, occupies the entire space marked off by the down and up strokes, in the same way that the spokes of a wheel in rapid motion apparently fill its area.

Flight essentially a gliding movement.—The angle at which the wing acts most efficaciously as a propeller and elevator, as indicated by an examination of the pinion of the living insect, bat, and bird when fully extended and ready to give the effective stroke, is something like one of 30° with the horizon. It varies, however, as has been explained, according as the animal is ascending, descending, or progressing at a high speed—the angle being least when the speed is greatest. As the angle adverted to could not be uniformly maintained without a rotatory motion which would wrench the wings from their fixings, the wing is made to rotate on its long axis to the extent of something less than a quarter of a turn in one direction during extension, and a corresponding amount in an opposite direction during flexion. Since the wing, in performing this movement, travels from the plane of least resistance till it makes the angle in question, and back again, at each vibration, a certain degree of power is dissipated in simply applying and withdrawing the surfaces. The movement, moreover, is not quite so uniform as it would be if complete rotation supervened. On this head, however, there is little ground for complaint, the wing being presented to and withdrawn from

the air with such dexterity as to rob flight to a great extent of its inequalities, by converting it into a more or less perfect gliding movement (Plate XV. fig. 59 *a a′* ; Diagram 6, p. 233). The down and up strokes, being essentially different and opposite movements, tend likewise to equalize each other. The gliding referred to is occasioned by the gradual extension and depression of the wing, during the down stroke, and its gradual flexion and elevation during the return or up stroke, the one movement, in fact, gliding into the other. The wing in action consequently describes a spiral course *from within outwards* and *from above downwards* during extension and the effective or down stroke, and *from without inwards* and *from below upwards* during flexion and the back or up stroke. The result of this is, that the wing is piercing the wind in two directions at nearly the same instant of time,—the interval which is consumed in extending and flexing the pinion being dedicated principally to applying it to and withdrawing it from the wind, that which elapses during the down and up strokes to urging the animal upwards and forwards. That the wing rotates upon its long axis, as explained, may be readily ascertained by watching the movement in the larger domestic fly. If the wing be viewed during its vibrations from above, it will be found that the blur, or impression produced on the eye by its action, is more or less concave (the under surface of the blur being convex). This is due to the fact that the wing is spiral in its nature (Plate XV. fig. 68), because, during its action, it twists upon itself in such a manner as to describe a double curve (Plate XV. fig. 58 *a a′* ; compare with *a a′* of fig. 52), the one curve being directed upwards (*a*), the other downwards (*a′*). The double curve or wave-track referred to is particularly evident in the flight of birds, from the greater size of their wings (Plate XV. figs. 73 and 75 *b a c*)*. It may not inaptly be compared to the blade of an ordinary screw propeller, as employed in navigation (Plate XV. fig. 52 *a a′*). The effect obtained, moreover, is in some respects analogous, since the great velocity with which the wing is driven converts the impression or blur (Plate XV. figs. 58 and 59) into what is equivalent to a solid for the time being, in the same way that the spokes of a wheel in violent motion, as is well understood, completely occupy the space contained within the rim or circumference of the wheel. The following differences are to be noted; and they are of importance, as they seem to prove very satisfactorily the immense superiority of the wing over every form of screw propeller yet constructed:—

Points wherein the screws formed by the wings differ from those in common use.—1. In the blade of the ordinary screw (Plate XV. fig. 52) the integral parts are rigid and unyielding, whereas in the blade of the screw formed by the wing (Plate XV. figs. 68, 69, and 70), and in the twisted blur produced by its action (Plate XV. figs. 58, 59, and 61), they are mobile and plastic. This is a curious and interesting point, the more especially as it does not seem to be either appreciated or understood. The mobility and plasticity of the wing is necessary because the pinion is an *elevating* and *sustaining organ*, as well as a *propelling* one.

* His Grace the Duke of Argyll is of opinion that the curvature of the wing in birds is owing to the elasticity and bending *upwards* of the tips of the primary, secondary, and tertiary feathers during the down stroke. It, however, also occurs in the wings of insects and bats, which are devoid of feathers; so that I am inclined to refer it, as stated, to the conformation of the wing and to its peculiar mode of action.

2. The vanes of the ordinary two-bladed screw have, as a rule, a very limited area, the area corresponding to their area of revolution. The wings, on the other hand, have a vast range (Plate XV. figs. 58, 59, and 61), and during their elevation and depression rush through an extensive space, the slightest movement at the root or axis of the wing being followed by a gigantic up or down stroke at the other. As a consequence, the wings as a rule act upon successive and undisturbed strata of air. The advantage gained by this arrangement in a thin medium like the air, where the quantity to be compressed is necessarily great, is simply incalculable.

3. In the ordinary screw the blades follow each other in rapid succession, so that they travel over nearly the same space, and operate upon nearly the same particles (whether water or air), in nearly the same interval of time. The limited area at their disposal is consequently not utilized, the action of the two blades being confined, as it were, to the same plane, and the blades being made to precede or follow each other in such a manner as necessitates the work being virtually performed only by one of them. This is particularly the case when the motion of the screw is rapid and the mass propelled is in the act of being set in motion, *i. e.* before it has acquired momentum. In this instance a large percentage of the moving or driving power is inevitably consumed in slip, from the fact of the blades of the screw operating on nearly the same particles of matter. It is otherwise with the wings. Here the blades, and the blurs which the blades produce when moving, are widely separated,—the one being situated on the right side of the body and corresponding to the right wing, the other on the left and corresponding to the left wing. The wings do not therefore follow each other and travel over the same space, or compress the same particles, at any stage of their progress. On the contrary, the right wing traverses and completely monopolizes the right half or hemisphere of a circle, the left wing in like manner appropriating and converting to its own uses the left and remaining half (Plate XV. figs. 58 and 59). The range or sweep of the two wings, when urged to their extreme limits, corresponds as nearly as may be to one entire circle *. By thus separating the blades of the screw, as happens in the wings, a double result is produced, since the blades always act upon independent columns of air and in no instance overlap or double upon each other. The advantages possessed by this arrangement are particularly evident when the motion is rapid—the natural screws formed by the wings being most efficient when the artificial ones are least so. As there seems to be no limit to the velocity with which the wings may be driven, and as increased velocity necessarily results in increased elevating, propelling, and sustaining power, we have here a striking example of the manner in which Nature triumphs over art even in her most ingenious, skilful, and successful creations.

There is yet another advantage which ought not to be overlooked. The same power which propels a screw composed of two blades will suffice, or very nearly suffice, for driving the detached widely separated blades of the screw formed by the wings.

4. The vanes or blades of the screw, as commonly constructed, are fixed at a given

* Of this circle, the thorax may be regarded as forming the centre, the abdomen, which is always heavier than the head, tilting the body slightly in an upward direction. This tilting of the trunk favours flight by causing the body to act after the manner of a kite.

angle, and consequently always strike at the same degree of obliquity. Here, again, power is lost, the two vanes striking after each other in the same manner, in the same direction, and almost at precisely the same moment,—no provision being made for increasing the angle, and the propelling-power, at one stage of the stroke, and reducing it at another, to diminish the amount of slip incidental to the arrangement. This result is obtained in marvellous perfection in the wings, and by a very simple contrivance, the angle which the pinions make with the horizon being gradually increased by the wings rotating on their long axes during the down or effective stroke, as it is usually termed, to increase the *elevating*- and *propelling*-power, and gradually decreased during the up or non-effective one to reduce the resistance occasioned by their ascent and backward movement, while it actually increases the *sustaining* area by placing the wing in a more horizontal position. It follows from this arrangement that every particle of air within the wide range of the wings is separately influenced by them, both during their ascent and descent,—the elevating-, propelling-, and sustaining-power being by this means increased to the utmost, while the slip or waftage is reduced to an infinitesimal and almost nominal amount. The effect aimed at is further secured by the undulatory or wave-like track described by the wing during the down and up strokes (Diagram 6, p. 233); and it is a somewhat remarkable circumstance that the wing, when not actually engaged as a propeller and elevator, acts as a *sustainer* after the manner of a parachute. This it can readily do, alike from its form and the mode of its application, the double curve or spiral into which it is thrown in action enabling it to lay hold of the air with avidity, in whatever direction it is urged. I say "in whatever direction," because, even when it is being recovered or drawn off the wind during the back stroke, it is climbing a gradient which arches above the body to be elevated, and so prevents it from falling. It is difficult to conceive a more admirable, simple, or effective arrangement, or one which would more thoroughly economize power. Indeed, a study of the spiral configuration of the wing, and its spiral, flail-like, lashing movements, involves some of the most profound problems in mathematics, —the curves formed by the pinion as a pinion anatomically, and by the pinion in action, or physiologically, being the most elegant and precise which it is possible to imagine, these running into each other, and merging and blending, to consummate the triple function of *elevating*, *propelling*, and *sustaining*. If further proof were necessary, it would be found in the fact that, during the down or effective stroke, the anterior and under extremity of the tip of the wing (Plate XV. fig. 62*f*) lays hold of the air with a biting or *concave surface* in a direction from above downwards, from behind forwards, and from without inwards, and forces it along a spiral groove on the under surface of the wing (*vide* arrows of figure) to the root of the same (*g*), where it causes it to escape by a *convex* one.

The under or ventral surface of the pinion is therefore engaged in elevating, propelling, and sustaining in a compound sense, one portion (the tip or outer part) *scaling* or *climbing* upwards and onwards, the root or inner portion aiding and abetting by *pushing* in a similar direction from beneath. In the return or back stroke, as has been explained, the curves formed by the under surface of the wing are reduced in such a manner as to decrease the amount of friction, while they increase, rather

than diminish, the extent of sustaining area, the back or upper convex surface of the pinion being turned in the direction in which the wing travels during its ascent.

5. In the ordinary screw propeller of commerce, the bilge or backwater of the one blade is urged towards and interferes with the action of the reciprocating and opposite blade; whereas in the wings, which are of necessity separated by the body which bears them, there is no such hindrance, and in fact no impediment whatever, each blade, *i. e.* each wing (Plate XIII. figs. 15 and 19; Plate XIV. figs. 31, 32, and 42) being free to utilize to the utmost the large subsidies of air on which it depends for support and progress.

6. The axis of revolution in the ordinary screw corresponds to the plane of progression (Plate XV. fig. 52). The axes of the wings, on the other hand, are at right angles to it (Plate XV. fig. 60). The wings may therefore be said to combine, during their action, the grasp and steadiness of the paddle with the easy subtle gliding motion peculiar to the helix.

Other differences might be pointed out; but the foregoing embrace the more fundamental and striking. Enough, moreover, has probably been said to show that it is to wing-structures and wing-movements the aeronaut must direct his attention, if he would learn "the way of an eagle in the air," and if he would rise upon the whirlwind in accordance with natural laws.

The Wing a twisted Lever or Helix—its peculiar screwing Action in the Insect, Bird, &c.—The twisting screw-like action of the wing on its long axis during the up and down strokes, as well as the range of the pinion (as seen in the Blow-fly) is given at figures 58 and 59 of Plate XV. It may be readily witnessed by fixing the insect and holding it, with its head directed towards the spectator, against a dark background. The twisting in question is most marked in the posterior or thin margin of the wing, the anterior and thicker margin performing more the part of an axis. As a result of this arrangement, the anterior or thick margin cuts into the air quietly, and as it were by stealth, the posterior one producing on all occasions a violent commotion, especially perceptible if a flame be exposed behind the insect. That the wing twists upon itself structurally, not only in the insect, but also in the bat and bird, any one may readily satisfy himself by a careful examination (Plate XV. figs. 68, 69, and 70); and that it twists upon itself during its action I have had the most convincing and repeated proofs (Plate XV. figs. 58, 61, 73, and 74). Indeed it is matter for surprise that the spiral conformation of the pinion, and its spiral mode of action, should have eluded observation so long; and I shall be pardoned for dilating upon the subject when I state my conviction that it forms the fundamental and distinguishing feature in flight, and must be taken into account by all those who seek to solve this most involved and interesting problem by artificial means *.

* In the early part of 1865 I devoted a large share of time and attention to wings and wing-structures, and to the flight of wild and tame birds. In this year also I propounded and explained my theory of the spiral configuration and screwing action of the pinion on its long axis during extension and flexion, and during the down and upstroke—the wing being, in my estimation, a true helix, worked by a twisting, screwing, or semirotatory movement emanating principally from the shoulder, but also from the elbow- and wrist-joints, the articular surfaces of which latter are distinctly spiral in their nature. In August 1866, I undertook to deliver a lecture on the subject at the Royal Institution

The spiral nature of the pinion is most readily recognized when the wing is seen from behind and from beneath (Plate XV. figs. 68, 69, 70, 73, and 74), and when it is foreshortened, as has been done in figures 61 and 62, Plate XV. It is also well marked in some of the long-winged oceanic birds when viewed from before (Diag. 18 A, *a′ b′*, *d′ e′ f″*, p. 253), and cannot escape detection, under any circumstances, if sought for,—the wing being essentially composed of a congeries of curves, remarkable alike for their apparent simplicity and the subtlety of their detail. The twisting or rotating of the wing on its long axis is particularly observable during extension and flexion in the bat and bird, and likewise in the insect, especially the Beetles, Cockroaches, and others which fold their

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of Great Britain, the title chosen being, "*the various Modes of Flight in relation to Aeronautics.*" The lecture in question was fixed for March 1867, and was published in the Proceedings of the Institution under date the 22nd of March, 1867. At pages 99, 100, and 101 of the Proceedings, the spiral conformation of the wing in the insect and bird is adverted to at length, it being there described as a twisted lever or helix, which owes its peculiar elevating- and propelling-power in a great measure to its shape. Particular emphasis is also placed upon the partial rotation of the wing on its long axis during extension and flexion, and to its screwing and unscrewing action during the down and up strokes, this being a *sine qua non* in flight. In the pages alluded to, the subjoined passages occur :—"All wings obtain their leverage by presenting oblique surfaces to the air, *the degree of obliquity gradually increasing in a direction from behind forwards and downwards* during extension when the sudden or effective stroke is being given, *and gradually decreasing in an opposite direction* during flexion, or when the wing is being more slowly recovered preparatory to making a second stroke. The effective stroke in insects—and this holds true also of birds—is therefore delivered *downwards* and *forwards*, and not, as the majority of writers believe, vertically or even slightly backwards." * * * * * "To confer on the wing the multiplicity of movement which it requires, it is supplied with a *double hinge* or *compound joint*, which enables it to move not only in an upward, downward, forward, and backward direction, but also at various intermediate degrees of obliquity." * * * * * "The wing of the bird, like that of the insect, is concavo-convex, and more or less twisted upon itself when extended, so that the upper or thick margin of the pinion presents a different degree of curvature to that of the nether or thin margin—the curves of the two margins in some instances even intersecting each other. This twisting is in a great measure owing to the manner in which the bones of the wing are twisted upon themselves, and the spiral nature of their articular surfaces, the long axes of the joints always intersecting each other at nearly right angles. As a result of this disposition of the articular surfaces, the wing may be shot out or extended, and retracted or flexed in nearly the same plane, the bones composing the wing rotating on their axes during either movement. This secondary action, or the revolving of the component bones upon their own axes, is of the greatest importance in the movements of the wings, as it communicates to the hand and forearm, and consequently to the primary and secondary feathers which they bear, the *precise angles* necessary for flight. It in fact ensures that the wing, and the curtain or fringe of the wing which the primary and secondary feathers form, *shall be screwed into and down upon the wind* in extension, *and unscrewed or withdrawn from the wind* during flexion. The wing of the bird may therefore be compared to *a huge gimlet or auger*, the axis of the gimlet representing the bones of the wing; the flanges or spiral thread of the gimlet the primary and secondary feathers. From this description it will be evident that by the mere rotation of the bones of the forearm and hand, the maximum and minimum of resistance is secured much in the same way that this object is attained *by the alternate dipping and feathering of an oar.*"

I have introduced the above quotations from a belief that, up to the date at which my lecture was published, viz. the 22nd of March, 1867, the twisted configuration of the pinion and its peculiar screwing action, occasioned by the manner in which the wing rotates on its long axis during flight, *were unknown*, and from finding that Mr. Joseph Meyers Kaufmann, of Glasgow, patented a flying-machine in which the movements of the wing described by me are more or less accurately reproduced, no allusion having been made to my researches, although at Mr. Kaufmann's request I forwarded a copy of my paper to him in March 1867, nearly five months prior to his taking out his patent. That Mr. Kaufmann was unacquainted with the movements in question will appear from the fact of no reference having been made to them in his preliminary specification or protection lodged in February 1867, while very considerable importance is attached to them in his actual patent taken out in August 1867. [Feb. 20, 1868.]

wings during repose. In these, in extreme flexion, the anterior or thick margin of the wing is directed *downwards*, and the posterior or thin one *upwards*. In the act of extension, however, the margins, in virtue of the wing rotating upon its axis, reverse their positions, the anterior or thick margin describing a spiral course *from below upwards*, the posterior or thin margin describing a similar but opposite course *from above downwards*. The movements of the margins during flexion and extension may be represented with a considerable degree of accuracy by a figure of 8 laid horizontally, as in Diagram 5.

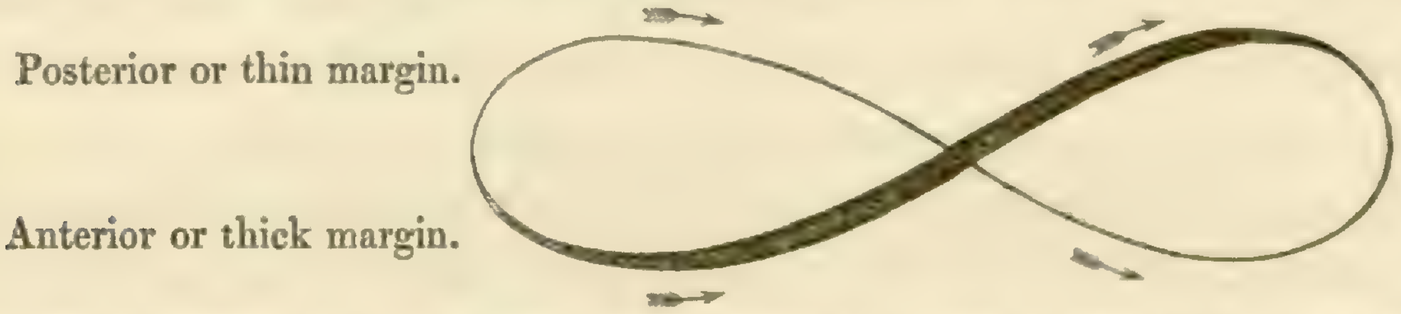


Diagram 5.

In this diagram (5) the course pursued by the anterior or thick margin of the pinion *during extension* is indicated by the thicker portion of the figure, that pursued by the posterior or thin margin by the thinner portion. These conditions, I need scarcely observe, are reversed during flexion.

From these remarks it will appear that not only the margins, but also the direction of the planes of the wing are more or less completely reversed at each complete flexion and extension; and it is this reversing or screwing and unscrewing which enables the wing to lay hold of the air with such avidity during extension and to disentangle itself with such facility during flexion—to present, in fact, a more or less concave, oblique, and strongly resisting surface the one instant, and a comparatively narrow, non-resisting, cutting edge the next.

The figure-of-8 action of the wing explains how an insect or bird may fix itself in the air, the backward-and-forward reciprocating action of the pinion affording support, but no propulsion. In these instances the backward and forward strokes are made to counterbalance each other.

The Wing, when advancing with the Body, describes a Wave-track.—Although the figure of 8 represents with considerable fidelity the twisting of the wing upon its axis during extension and flexion, when the insect is playing its wings before an object, or still better when it is artificially fixed, it is otherwise when the down stroke is added and the insect is fairly on the wing and progressing rapidly. In this case the wing, in virtue of its being carried forward by the body in motion, describes an undulating or spiral course, as shown in the accompanying diagram (6), where the

Diagram 6.

thick portions (a, b) of the spiral, represent the effective or down strokes, the thin portions (c, d, e) the up or back strokes.

From this diagram (6) it will be evident that the resistance offered by the wing to

the plane of progression is greatest at the middle of the down stroke (*x*), when the pinion makes an angle of 30° or thereabouts with the horizon*, and least during the middle of the up stroke (*d*), when the wing presents a narrow or cutting edge to the wind. This is occasioned by the gradual *increase* in the angle made by the wing with the horizon during the first part of the down stroke (*f*), and its gradual *diminution* during the second part (*g*). The angle is diminished during the second part of the down stroke to prepare the wing for commencing the up or back stroke, the pinion being gradually rotated off the wind to present less and less resistance. This result is facilitated during the back stroke by the concavity of the wing travelling along the convexity of the curve *d*, this being the direction in which the wing is raised preparatory to a second down stroke. The down and up strokes are consequently compound movements,—the termination of the down stroke, as has been explained, embracing the beginning of the up stroke, the termination of the up stroke, on the other hand, including the beginning of the down stroke. This is necessary in order that the down and up strokes may glide into each other in such a manner as to prevent jerking and unnecessary retardation,—the angle made by the wing during the first part of the down stroke being increased to support and propel the insect, and decreased during the second part to diminish the friction caused by the wing itself, while it does not interfere with its sustaining-power.

Analogy between the wing in motion and the sounding of sonorous bodies, &c.—What has just been said of the wing of the insect holds equally true of the pinion of the bat and bird; and it is a remarkable circumstance that the undulation or wave made by the wing when the insect and bird are fixed or hovering before an object, and when they are progressing, corresponds in a marked manner with the track described by the stationary and progressive waves in fluids †, and likewise with the waves of sound ‡. This coincidence would seem to argue an intimate relation between the instrument and the medium on which it is destined to operate—the wing acting in those very curves into which the atmosphere is naturally thrown in the transmission of sound, in order, as appears to me, to secure the maximum of progression with the minimum of slip. Can it be that the animate and inanimate world reciprocate, and that animal bodies are made to impress the inanimate in precisely the same manner as the inanimate impress each other? This much seems certain:—The wind communicates to the water similar impulses to those communicated to it by the fish in swimming; and the wing in its vibrations impinges upon the air as an ordinary sound would. The extremities of quadrupeds, moreover, describe spiral tracks on the land when walking and running; so that one great law would seem to determine the course of the insect in the air, the fish in the water, and the quadruped on the land.

* The down stroke is most effective towards the middle of the undulation for two reasons:—first, because the angle made by the wing with the horizon is greatest at this period; and secondly, because the wings are then on the same level with the body, and therefore expanded to the utmost. The expansion of the wings is well seen in fig. 1, plate xiii. of Borelli's 'De motu Animalium,' 1680.

† Handbook of Natural Phil. (vol. on Electricity, Magnetism, and Acoustics), by Dr. Lardner, (Lond. 1863) pp. 366–7.

‡ *Op. cit.* pp. 378, 379, 380.

The inference to be deduced from this correspondence between the twisting *wave-like* action of the pinion and the sinuous movements of the swimming-animals, whether these occur in their bodies, tails, fins, flippers or feet, is this—that the liquid media of the water and air respond to similar impulses, whatever the direction of the impulse (the flying wing strikes *forwards*, and the diving and swimming wing and foot *backwards*), and that the gliding spiral movements which are indispensable to the successful navigation of the air and water differ in no essential particular from those required in land transit as witnessed in the ordinary movements of walking and running. Compare the spiral track described by the wing in action (Diagram 6 of text) with the movements of the fish (fig. 76, Plate XV.), with those of the feet of swimming-birds (fig. 77, Plate XV.), and with those described by our own extremities in walking (fig. 78, Plate XV.).

The down and up strokes of the wing consist of four stages.—The action of the wing may be conveniently divided into four stages,—the first being devoted to preparing the wing for making the down stroke, *i. e.* in elevating it above the body and in distending it when necessary; the second, to the down or effective stroke, as it is usually termed; the third, to preparation for raising and flexing the wing (when this is required) prior to the up or back stroke; the fourth, to the so-called non-effective, up or back stroke. These movements, however, be it understood, are continuous and run into each other (Diagram 6, p. 233). In the first stage the wing supports or sustains, and partially elevates; in the second it elevates, propels, and sustains to an extent which is quite remarkable; in the third it sustains and partially elevates, as in the first; and in the fourth and last it acts chiefly as a sustainer, although it also acts as an elevator by being carried against the wind by the body which is in motion.

In the first stage the angle which the wing makes with the horizon may be stated at from 15° to 20°; in the second it increases to something like one of 30°; in the third it gradually diminishes again to 15° or 20°; and in the fourth it probably does not exceed 5° or 10°. The angle, as has been stated, consequently gradually increases, and attains a maximum towards the middle of the down or effective stroke (Diagram 6 *x*), whereas it decreases and attains a minimum towards the middle of the non-effective or up stroke (Diagram 6 *d*). The terms effective and non-effective are here used in a comparative and not an absolute sense.

The wings may or may not present the proper angle for flight when the insect is reposing; and when they do not, a certain degree of preparation is necessary before the insect can take wing. In the Butterfly the wings during repose are raised vertically above the body (Plate XIII. fig. 26), so that they require to be lowered and slewed round until they make the requisite angle before flight can be effected. In the Cicada, on the other hand, where the wings droop (Plate XIII. fig. 25), they require to be raised and rotated till the desired angle is obtained; so that it is only in such insects as the Dragon-flies (Plate XIII. fig. 24), where the angle during repose and in flight approaches to 30°, that flight is instantaneous. It matters not, therefore, whether the wings in leaving their position of rest roll from above downwards, or from below upwards, if when fully extended, they make the angle of 30° with the horizon, as specified. The Beetles are illustrative in these respects. In them the wings, when the insect is at rest, are arranged

transversely upon the back beneath the elytra. When flight is contemplated, the elytra, or first pair of wings, are raised and carried forward (Plate XIII. fig. 16 *r*). When they make a right angle with the long axis of the body, they present their plane of least resistance; but by the time they travel other 45° or so (Plate XV. fig. 56), which they do to get beyond the reach of the membranous or second pair of wings (Plate XIII. fig. 16 *e*), they acquire the degree of obliquity necessary for flight, and act mechanically as gliders. When the membranous or second pair of wings are extended until they make a right angle with the body, they do not, as in the case of the elytra, present their plane of least resistance, but an angle of 30° or so with the horizon, so that they are then in a proper position for making the effective or down stroke. In some instances, as in the Cockroaches, where the elytra or first pair of wings are semimembranous and slightly twisted upon themselves (Plate XIII. fig. 21*r*), they are geared to the second pair (*a*), so that the upper and lower wings act together to obtain a common result. The range of the wing (when the angle of flight is attained) varies greatly in different insects—in some equaling the quarter of a circle, in others three-eighths of a circle, and in others quite a half (Plate XV. fig. 58 *a a'*). The wings, moreover, I have good reason to believe, can be made to oscillate within given areas anteriorly, posteriorly, or centrally with regard to the plane of the body, or in intermediate positions with regard to it and a perpendicular line. The wing or wings of the one side can likewise be made to move independently of those of the other, so that the centre of gravity, which, in insects, bats, and birds, is suspended, is not disturbed in the endless evolutions involved in ascending, descending, and wheeling. The centre of gravity varies in insects according to the shape of the body, the length and shape of the limbs and antennæ, and the position, shape, and size of the pinions. It is corrected in some by curving the body, in others by bending or straightening the limbs and antennæ, but principally in all by the judicious play of the wings themselves.

To confer on the pinion the multiplicity of movement which it requires, it is supplied with a double hinge or compound joint, which enables it not only to move in an upward, downward, forward and backward direction, but also at various intermediate degrees of obliquity. An insect furnished with wings thus hinged may, as far as steadiness of body is concerned, be not inaptly compared to a compass set upon gimbals, the universality of the wing-movements rendering any elaborate attempt at balancing quite unnecessary. The rapidity with which the wing oscillates is, with few exceptions, very great, the velocity, as a rule, increasing as the area of the wing (as compared with that of the body) decreases. The wing, during its passage through the air, in many instances emits a loud drumming sound or note, which is high or low as the vibrations are rapid or the reverse. These sounds have been thought by some to afford an infallible indication of the number of the vibrations made by the wing during any given period. Unfortunately, however, for this theory, the sounds in question, although frequently, are not always produced by wing-structures; so that the pitch of the note cannot be explained on the theory of vibrations as applied to acoustics.

I have endeavoured to show that flight is secured in the insect, not because its body, as compared with the atmosphere, is comparatively light, but because its power, as compared with its size, is very great,—this power enabling it to apply its wings to, and with-

draw them from, the air with astonishing velocity *at various degrees of obliquity*, to obtain the maximum of resistance in a downward direction, and the minimum of displacement in an upward one—to convert them, in fact, into spiral inclined planes, with which to tread the air and rise upon it, as a kite upon the wind or a swimmer upon the water. I use the phrase "*various degrees of obliquity*" because, although the effective or down stroke is delivered at an angle of 30° or thereabouts, the wings act more or less perfectly as elevators and propellers from the moment they leave their position of rest or plane of least resistance until they make the angle referred to, and likewise during the up or back stroke, when the wings are being recovered. The power of the insect is consequently conserved and utilized to an astonishing degree.

It only remains for me to allude briefly to the manner in which the wings are moved.

Arrangement for moving the Wings of Insects &c.—In all insects, with the exception of the Dragonflies, the muscles which play the wings are confined within the barrel-shaped thorax, to which the wings are articulated. They consist of a vertical and a transverse set,—the transverse set, by their contraction, compressing the cylinder laterally, and causing its mesial portion *to ascend*, and the wings *to descend*; the vertical set, by their contraction, compressing the cylinder from above downwards, and causing the wings *to ascend*, according as the vertical measurement of the thorax is reduced by lateral bulging*. While the wings are ascending and descending, they are obliged to rotate on their long axes—the spiral configuration of the joints, and the arrangement of the elastic and other structures which bind them to the body, conferring on them the various degrees of obliquity which characterize the down and up strokes (vide pages 226 and 227). Since the two sets of muscles act alternately, as in the auricles and ventricles of the heart, the one set rests while the other is active; and it is just possible that in this and in the action of the elastic ligament which recovers or flexes the wing we have an explanation, not only of the prodigious power wielded by insects, but also of their endurance. In the *Libellulæ* or Dragonflies, the muscles are inserted into the root of the wing as in the bat and bird, the only difference being that in the latter the muscles creep along the wing to its extremity. In all the wings which I have examined, whether in the insect, bat, or bird, the wing is recovered, flexed, or drawn towards the body by the action of an elastic ligament, this structure, by its mere contraction, causing the wing, when fully extended

* The following is the account given by Chabrier:—"It is generally through the intervention of the proper motions of the dorsum, which are very considerable during flight, that the wings or the elytra are moved equally and simultaneously. Thus, when it is elevated, it carries with it the internal side of the base of the wings with which it is articulated, from which ensues the depression of the external side of the wing; and when it approaches the sternal portion of the trunk, the contrary takes place and the wings are raised. During the depression of the wings, the dorsum is curved from before backwards, or in such a manner that its anterior extremity is brought nearer to its posterior, that its middle is elevated, and its lateral portions removed further from each other. The reverse takes place in the elevation of the wings; the anterior extremity of the dorsum being removed to a greater distance from the posterior, its middle being depressed, and its sides brought nearer to each other. Thus its bending in one direction produces a diminution of its curve in the direction normally opposed to it; and by the alternations of this motion, assisted by other means, the body is alternately compressed and dilated, and the wings are raised and depressed by turns."—*General Observations on the Anatomy of the Thorax in Insects, and on its Functions during Flight*, by E. T. Bennett, F.L.S., &c. (Extracted chiefly from the "Essai sur le vol des Insectes, par J. Chabrier," Mém. du Muséum d'Histoire Naturelle; Zool. Journal, vol. i. art. xlvi. 1825.)

and presenting its maximum of surface, to resume its position of rest and plane of least resistance. The principal effort required in flight would therefore seem to be made during extension, or when the effective stroke is being given. The elastic ligament is variously formed, and the amount of contraction which it undergoes is in all cases accurately adapted to the size and form of the wing and the rapidity with which it is worked—the contraction being greatest in the short-winged and heavy-bodied insects and birds, and least in the light-bodied and ample-winged ones, particularly in such as skim or glide. The mechanical action of the elastic ligament, I need scarcely remark, ensures an additional period of repose to the wing at each stroke, and this is a point of some importance as showing that the lengthened and laborious flights of insects and birds are not without their stated intervals of rest.

Speed attained by Insects.—Many instances might be quoted of the marvellous powers of flight residing in insects as a class. The male of the Silkworm-Moth (*Attacus Paphia*) is stated to travel more than 100 miles a day*; and an anonymous writer in Nicholson's Journal† calculates that the common House-fly (*Musca domestica*), in ordinary flight, makes 600 strokes per second, and advances 25 feet, but that the rate of speed, if the insect be alarmed, may be increased six- or sevenfold, so that under certain circumstances it can outstrip the fleetest racehorse. Leeuwenhoek relates a most exciting chase which he once beheld in a menagerie about 100 feet long between a Swallow and a Dragonfly (*Mordella*). The insect flew with such incredible speed, and wheeled with such address, that the Swallow, notwithstanding its utmost efforts, completely failed to overtake and capture it‡.

THE WINGS OF BATS.

Where the Bat's Wing agrees with and differs from that of the Insect and Bird.—The wing of the bat (Plate XV. fig. 66) bears considerable resemblance to that of the insect (Plate XV. fig. 65), inasmuch as it consists of a delicate, semitransparent, continuous membrane, supported in divers directions, particularly towards its anterior margin (Plate XV. fig. 66 *d e f*), by a system of stays or stretchers (*a, b, f*), which confer upon it the degree of rigidity requisite for flight. The supports in this instance consist of the bones of the arm, forearm, and hand; and as these fold upon themselves (*e*) during the period of repose, they bear a certain analogy to the neuræ or nervures in the wing of the beetle (Plate XV. fig. 65 *d, e, f, c, a, b*). Indeed, if the wing of the bat and that of some of the larger beetles be compared, they will be found to possess many features in common. They especially resemble each other in their general contour and the manner in which their horny and osseous supports taper from within outwards (*d, e, f*), and from before backwards (*c, a, b*). The wing of the bat varies in shape, as do the wings of insects and birds, in some cases being short and broad (Plate XV. fig. 66), in others elongated and narrow (Plate XIII. fig. 15). It also differs as regards relative proportion, on some occasions being ample with regard to the body, in others comparatively scanty. It is, as a

* Linn. Trans. vii. p. 40.

† Vol. iii. p. 36.

‡ "The Hobby Falcon, which abounds in Bulgaria during the summer months, hawks *large Dragonflies*, which it seizes with the foot and devours whilst in the air. It also kills Swifts, Larks, Turtledoves and Bee-birds, although more rarely."—*Falconry in the British Isles*, by Francis Henry Salvin and William Brodrick. Lond. 1855.

rule, deeply concave on its under or ventral surface (Plate XIII. fig. 15), and in this respect resembles the wing of the Rasores or heavy-bodied birds (Plate XIV. figs. 31 and 32). It differs from the wing of the bird in being supported, in addition to the bones of the arm and hand, by the bones of the feet and tail, and likewise by the back and side of the body, and in presenting an uninterrupted or continuous membrane both in flexion and in extension. If the tail is long, the area of the wing is increased, this with the legs distending and supporting the membrane in a backward direction. This arrangement facilitates the evolutions of the bat on the wing, the elevation or depression of the feet and tail, and the spreading thereof, assisting it in ascending, descending, and turning.

The Bones of the Wing of the Bat—the spiral configuration of their articular surfaces.—The bones of the arm and hand are especially deserving of attention. The humerus (Plate XIII. fig. 15 *r*) is short and powerful, and twisted upon itself to the extent of something less than a quarter of a turn. As a consequence, the axis of the shoulder-joint is nearly at right angles to that of the elbow-joint. Similar remarks may be made regarding the radius (the principal bone of the forearm) (*d*), and the second and third metacarpal bones with their phalanges (*e f*), all of which are greatly elongated, and give strength and rigidity to the anterior or thick margin of the wing. The articular surfaces of the bones alluded to, as well as of the other bones of the hand, are spirally disposed with reference to each other, the long axes of the joints intersecting at nearly right angles. The object of this arrangement is particularly evident when the wing of the living bat, or of one recently dead, is extended and flexed as in flight *.

Extension and Flexion in the Wing of the Bat.—In the flexed condition the humerus and the second and third metacarpal bones, with their phalanges, are parallel to each other, the radius and ulna being raised a little above the others, and the fourth and fifth metacarpal bones, with their phalanges, a little below—the whole being parallel, or nearly parallel, with the long axis of the body. In the flexed state the surface of the wing is diminished to its utmost, so that it presents its narrow edge to the wind. When extension takes place the elbow-joint is depressed and carried forwards, the wrist elevated and carried backwards, the metacarpo phalangeal joints lowered and inclined forwards, and the distal phalangeal joints slightly raised † and carried backwards. The movement of the bat's wing in extension is consequently a spiral one, the spiral running alternately from below upwards and forwards, and from above downwards and backwards. As the bones of the arm, forearm, and hand rotate on their axes during the extensile act, it follows that the posterior or thin margin of the wing is rotated in a downward direction (the anterior or thick one being rotated in an opposite direction) until the wing makes an angle of something like 30° with the horizon, which, as I have already endeavoured to show, is the greatest angle made by the wing in flight. When the wing is fully extended it presents its surface of greatest resistance, and is then in

* I had the good fortune, when engaged on this part of my subject, to obtain the body of one of the larger Bats (a species of *Pteropus*) immediately after death. By its aid I was enabled to determine many points which had escaped me in previous examinations.

† The raising of the distal phalanges enables the Bat to arrange the distal portions of the wing upon the back during extreme flexion when the animal is reposing.

a position to give the effective or down stroke, which is delivered *downwards and forwards*, as in the insect. These movements are reversed during flexion. The action of the bat's wing at the shoulder is particularly free, partly because the shoulder-joint is universal in its nature, and partly because the scapula participates in the movements of this region. The freedom of action referred to enables the bat not only to rotate and twist its wing as a whole, and so diminish or increase the angle which it makes with the horizon, but to rotate or screw it in an upward and downward direction, and likewise in a forward and backward one. The rotatory or twisting movement of the wing is an essential feature in flight, as it enables the bat (and this holds true also of the insect and bird) to balance itself with the utmost exactitude and to change its position and centre of gravity with marvellous dexterity. The movements of the shoulder-joint are restrained within certain limits by a system of check-ligaments, and by the coracoid and acromian processes of the scapula; and the wing is recovered or flexed by the action of an elastic ligament extending between the shoulder and the elbow along the anterior margin of the wing, and by elastic and fibrous structures situated between the fingers and in the substance of the wing generally. The bat flies with great ease and for lengthened periods. Its flight is remarkable for its softness, in which respect it surpasses the owl and the other nocturnal birds. The action of the wing of the bat, and the movements of its component bones, are essentially the same as in the bird.

THE WINGS OF BIRDS.

Traces of Design in the Wing of the Bird—the arrangement of the primary, secondary, and tertiary feathers, &c.—There are few things in nature more admirably constructed than the wing of the bird, and perhaps none where design can be more readily traced. Its great strength and extreme lightness, the manner in which it closes up or folds during flexion, and opens out or expands during extension, as well as the manner in which the feathers are strung together and overlap each other in divers directions to produce at one time a solid resisting surface, and at another an interrupted and comparatively non-resisting one, present a degree of fitness to which the mind must necessarily revert with pleasure. If the feathers of the wing only are contemplated, they may be conveniently divided into three sets of three each (on both sides of the wing)—an upper or dorsal set (Plate XV. fig. 63 *d*, *e*, *f*), a lower or ventral set (*c*, *a*, *b*), and one which is intermediate. This division is intended to refer the feathers to the bones of the arm, forearm, and hand, but is more or less arbitrary in its nature. The lower set or tier consists of the primary (*b*), secondary (*a*), and tertiary (*c*), feathers, strung together by fibrous structures in such a way that they move in an outward or inward direction, or turn upon their axes, at precisely the same instant of time,—the middle and upper sets of feathers, which overlap the primary, secondary, and tertiary ones, constituting what are called the "coverts" and "subcoverts." The primary or rowing-feathers are the longest and strongest (*b*), the secondaries (*a*) next, and the tertiaries third (*c*). The tertiaries, however, are occasionally longer than the secondaries. The tertiary, secondary, and primary feathers increase in strength from within outwards, *i. e.* from the body towards the extremity of the wing, and so of the several sets of wing-coverts. This

arrangement is necessary because the strain on the feathers during flight increases in proportion to their distance rom the trunk.

The Wing of the Bird twisted upon itself; its shape &c.—The feathers, as will be seen from this description, become longer and stronger from before backwards and from within outwards; and the length and shape of the various sets of feathers, particularly the primaries, determine to a great extent the shape of the wing. Thus, if the first primary be longest, as in the Golden Plover, Curlew (Pl. XIV. fig. 35), the wing is acuminate; whereas if the third or even the fourth be longest, as happens in the Partridge (Pl. XIV. fig. 32) and Pheasant, the wing is rounded or circular. Between these extremes every variety of form may be encountered *.

Although the feathers are longest and strongest towards the extremity of the wing, it does not follow that the wing itself is strongest in this direction. On the contrary, it is strongest towards the axilla or shoulder, the unwieldy or weighty parts being in this manner placed nearer the centre of gravity (which in birds falls between the wings, somewhere in the pectoral region †), where they are more immediately under control. The wing of the bird in this respect closely resembles the wing of the insect, both tapering from before backwards, and from within outwards, and presenting on section a conical surface in either direction. The wing of the bird, like that of the insect and bat, is concavo-convex (Plate XIV. figs. 28 & 32), and more or less twisted upon itself when extended (p. 253, Diagram 18 A. $d'\,e'\,f'$, $a'\,b'$), so that the upper or thick margin of the pinion presents a different degree of curvature from that of the nether or thin margin, the curves presented by the two margins in the majority of instances intersecting each other (Pl. XV. fig. 70 $d\,f$, $c\,b$; also Diagram 18 A. $d'\,e'\,f'$, $a'\,b'$). This is in a great measure owing to the arrangement of the primary, secondary, and tertiary feathers, to the manner in which the bones of the wing of the bird are twisted upon themselves, and to the spiral nature of their articular surfaces,—the long axes of the joints, as in the bat, always intersecting each other at nearly right angles.

The Wing of the Bird moveable in all its parts; the curves formed by it in extension and flexion.—The double twisting-process to which I refer is particularly well seen in Pl. XIV. fig. 29; and to this I would specially direct the attention of the reader, as it shows how, during flexion, the anterior or thick margin of the wing is slightly *directed downwards* ($e\,f$), the pinion presenting a narrow cutting edge to the wind; whereas during extension, the anterior or thick margin is very decidedly *directed upwards* ($d'\,e'\,f'$), the wing in this case presenting its maximum of surface. The kite-

* "The wing is short, broad, convex and rounded in Grouse, Partridges, and other Rasores; long, broad, straight, and pointed in most Pigeons. In the Peregrine Falocn it is acuminate, the second quill being longest, and the first little shorter; and in the Swallows this is still more the case, the first quill being longest, the rest rapidly diminishing in length."—*Macgillivray, Hist. Brit. Birds,* vol. i. p. 82. "The hawks have been classed as noble or ignoble according to the length and sharpness of their wings: and the Falcons, or long-winged Hawks, are distinguished from the short-winged ones by the second feather of the wing being either the longest or equal in length to the third, and by the nature of the stoop made in pursuit of their prey."—'*Falconry in the British Isles,*' *by F. H. Salvin and W. Brodrick,* Lond. 1855, p. 28.

† "In flight the centre of gravity is brought forward beneath the origin of the wings; but in standing it is carried various degrees backwards."—*Macgillivray, Hist. of Brit. Birds.* p. 47.

like action of the fully extended pinion, and the feathering principle (to use a nautical phrase) of the partially flexed one, may readily be inferred from this figure. It is further illustrative as showing the great facility with which a bird may elevate or depress its body, and how it may turn and wheel without the possibility of a mishap. The anterior or thick margin of the wing and the posterior or thin margin present different degrees of curvature, so that under certain conditions the two margins cross each other and form a true helix, as represented at Figs. 70, 73, and 74, Pl. XV. The anterior margin presents two well-marked curves, a corresponding number being found on the posterior margin. These curves may for the sake of clearness be divided into *axillary* curves and *distal* curves, the former occurring towards the root of the wing, the latter towards its extremity. The curves (axillary and distal) found on the anterior margin of the wing are always the reverse of those met with on the posterior margin; *i. e.*, if the convexity of the anterior axillary curve be directed *downwards* (Pl. XV. fig. 73 *e*), that of the posterior axillary curve is directed *upwards* (Pl. XV. fig. 73 *a c f*), and so of the anterior (*f*) and posterior (*b*) distal curves. The two curves occurring on the anterior margin of the wing (axillary and distal) are likewise antagonistic, the convexity of the axillary curve being always directed *downwards* (Pl. XV. fig. 73 *e*) when the convexity of the distal one is directed *upwards* (Pl. XV. fig. 73 *f*), and *vice versâ*. The same holds true of the axillary and distal curves occurring on the posterior margin of the wing (Pl. XV. fig. 73 *a c b*). In some birds, particularly where the wings are large and there is a considerable degree of movement permitted between the phalangeal or finger-bones bearing the primary feathers, there is a tendency to multiply or repeat the curves towards the tip of the wing. This was particularly the case in the wing of a Wild Swan, a fine specimen of which I had the good fortune to purchase at one of the London markets. In the wing of this magnificent bird, the movement permitted between the phalanges was such that in extreme extension the feathers were rotated in a slightly upward direction towards their roots, the movement extending to the tip of the feathers, and producing an additional or third curve at the extremity of the wing. The third curve is smaller than the others and has its concavity directed upwards. At first sight it appears as if it were produced by the bending upwards of the primary feathers, which I have satisfied myself is not the case. The yielding of the joints towards the extremity of the wing is serviceable in two ways, viz. in preventing shock when the pinion is forcibly depressed, and, secondly, in introducing, as it were, the wing to the air, which acts as its fulcrum or pivot of support.

The different Curves formed by the Wing reverse during its action.—The anterior axillary and distal curves completely reverse themselves during the acts of extension and flexion, and so of the posterior axillary and distal curves. This reversal of the curves is seen to most advantage in the posterior margin of the wing, formed, in the bird, by the primary, secondary, and tertiary feathers. It is well represented at Pl. XV. figs. 73, 74, & 75. In fig. 73 the wing is partially flexed, the convexity of the distal curve (*b*) being directed *downwards*, that of the axillary curve (*a c*) *upwards*. In fig. 74 the wing is rather more than half extended; and in this condition of the pinion the curves are obliterated, the posterior margin becoming straight,

as shown at *b c*. It is at this stage of extension that the axillary and distal curves reverse. In fig. 75 the wing is fully extended, the convexity of the axillary curve (*c*) being directed *downwards*, that of the distal one (*a b*) *upwards*. This, I need scarcely remark, is the reverse of what occurred in flexion, as a comparison of *b a c* of Pl. XV. fig. 73 with the corresponding letters of Fig. 75 will satisfactorily show. The axillary and distal curves formed by the posterior or thin margin of the wing when fully extended are also well shown at Pl. XV. fig. 62 *b a c*.

The cross Pulsations produced by the Wing in motion. Resemblance between the Flight of Birds, the Swimming of Fishes, &c.—From this description it follows that, when the different portions of the anterior margin are elevated, corresponding portions of the posterior margin are depressed, the different parts of the wing moving in opposite directions, and playing, as it were, at cross purposes for a common good—the object being to rotate or screw the wing down upon the wind at *a gradually increasing angle* during extension, and to rotate it in an opposite direction and withdraw it at *a gradually decreasing angle* during flexion. It also happens that the axillary and distal curves coordinate each other and bite alternately, the distal curve posteriorly seizing the air in extreme extension with its concave surface (while the axillary curve relieves itself by presenting its convex surface), the axillary curve, on the other hand biting during flexion with its concave surface (while the distal one relieves itself by presenting its convex one). The wing may therefore be regarded as exercising a fourfold function, the pinion being made to move from *within outwards and from above downwards* during extension in the effective or down stroke, and *from without inwards and from below upwards* during flexion in the up or return stroke. The wing consequently acts as an elevator and propeller, during both the down and up strokes, the anterior and posterior margins of the pinion presenting concave and convex surfaces alternately to suit the varying position of the wing during its descent and ascent, it being so arranged that there is always a concave or biting surface to lay hold of the air, and a convex one to facilitate its escape when its presence might retard the upward and onward movement of the bird. This oscillating of the wing on two separate axes—the one running parallel with the body of the bird, the other at right angles to it, is well worthy of attention as showing that the wing attacks the air on which it operates in every direction and at almost the same moment, viz. from within outwards and from above downwards, during the down or effective stroke, and from without inwards and from below upwards during the up or return stroke. As a corollary to the foregoing, the wing may be said to agitate the air in two principal directions, viz. *from within outwards or the reverse*, and *from behind forwards or the reverse*, the agitation in question producing two powerful pulsations, a longitudinal and a lateral. As, however, the curves of the wing glide into each other when the wing is in motion, so the one pulsation merges into the other by a series of intermediate and lesser pulsations. The fish, as a reference to pp. 204, 205, and 206 will show, also produces two principal pulsations in swimming, the one being from before backwards or the reverse, the other from side to side. The fish may be said to drill the water in two directions, viz. from behind forwards by a twisting or screwing of the body on its long axis, and from side to side by causing its anterior and

posterior portions to assume opposite curves. The longitudinal and lateral pulsations occasioned by the wing in action may be fitly represented by spiral wave-tracks running at right angles to each other. The lateral wave-track (Pl. XV. figs. 73 & 75 *b a c*) is the more distinct. It is usually correctly portrayed by artists in their landscapes and sea-pieces, and is ascribed by His Grace the Duke of Argyll * to the bending *upwards* of the feathers during the descent of the wing. I am, however, disposed to attribute it not so much to the bending of the feathers, which would imply weakness or imperfection in the materials employed, as to the *general arrangement* of the feathers, to the peculiar movements of the articular surfaces of the bones of the wing, and to the conformation of the wing as a whole.

The Curves formed by the Wing in motion not due to the upbending of the Feathers.—That the double curve presented by the wing in action is not referable to adventitious pressure and yielding, but to the peculiar structure of the pinion, is rendered extremely probable by the fact that it is found in the wing of the insect (Pl. XV. fig. 68 *c b*) and bat (Pl. XV. fig. 69 *c b*), where no feathers are present, and in the wing of the bird when it is artificially dried in the extended position (Pl. XV. fig. 62 *g a b*), and where consequently neither pressure nor yielding could occur. The wing, moreover, in the dried state (when the joints are immobile), is so rigid that, strike the air with it as you will, it is impossible to detect any upbending of either the primary or secondary feathers.

Perhaps the most conclusive argument that can be adduced against the theory of the upward bending of the feathers while the wing is descending, is to be found in the fact (*vide* experiments pp.219, 220, and 221) that the posterior margin of the pinion, both in the insect and bird may be completely removed without impairing the function of flight. This circumstance would certainly lead us to infer that the wing derives its power from inherent or structural, rather than accidental properties—the curves and the fundamental form of the wing being in no wise impaired by the mutilation. In corroboration of the opinion that no upbending of the feathers occurs during the effective or down stroke of the wing, it may be stated that the pressure which would produce it, does not naturally fall on the posterior margin of the pinion, formed by the primary, secondary, and tertiary feathers, but upon the anterior or thick margin composed of the integument, alar ligament, bones, muscles, and the roots or stronger portions of the feathers in question. When, moreover, the wing is driven with great velocity, and the speed attained by its rapid oscillation, by gliding or otherwise, is high, the pressure, curiously enough, falls more and more *on the anterior or front edge of the wing*, where it is strongest, and where consequently it is best able to withstand the strain to which it is subjected. The law regulating the accumulation of the pressure on the anterior or front edge of the wing at high velocities has been worked out by Mr. F. H. Wenham † in a very able and ingenious paper, and is more fully explained in a footnote to p. 258. The bending upwards of the wing towards its tip is usually observed when the bird is flying from or towards the spectator, and may be referred either to the posterior distal curve pointing downwards

* 'The Reign of Law,' p. 143. London: 1867.

† "On Aerial Locomotion, and the laws by which heavy bodies impelled through air are sustained," Annual Report of the Aeronautical Society of Great Britain, 1867.

as in partial flexion (Pl. XV. fig. 73 *b*), or to the elevation of the posterior distal portion of the wing (Pl. XV. fig. 69 *b*) and the depression of the corresponding anterior portion (Pl. XV. fig. 69 *f*), as happens when the posterior margin of the wing is rotated in an upward direction at the beginning of the up or return stroke. In this case, the posterior margin (Plate XV. fig. 69 *b*) is lost to view, the anterior margin (*f*), which is bent *upwards* towards the extremity of the wing, being alone seen. Finally, as has been explained, it may be referred to the upward direction communicated to the primary feathers by the metacarpal and phalangeal bones of the wing rotating or twisting on their long axes in the direction indicated.

Natural Outlet for the Air towards the root of the pinion; the bending upwards of the feathers for this purpose unnecessary.—The bending upwards of the shafts of the feathers during the descent of the wing would, I opine, impair its efficacy by permitting more air to escape along its posterior or thin margin than is necessary, the air by this arrangement being diverted from its real outlet, which occurs towards the root of the pinion, where the secondary and tertiary feathers approach each other. In this locality a very beautiful provision is made for its exit, it so happening that the secondary feathers with their coverts and subcoverts, on both the dorsal and ventral aspects, run obliquely from without inwards, or towards the body of the bird; while the corresponding tertiary feathers proceed in a slanting direction from within outwards, *i. e.* in the direction of the tip of the wing. The result of this arrangement is obvious: the secondary and tertiary feathers, proceeding obliquely in opposite directions, meet at a certain angle, and form by their union on the ventral or under surface of the wing, to which the present description more particularly applies, a conical depression, or hollow, the base of which is directed upwards and outwards, towards the anterior margin and body of the wing—the apex downwards and inwards, towards the posterior margin and root of the pinion. It is in this latter situation that the air on which the wing has acted escapes in a concentrated form, the recoil which it elicits urging the body of the bird in an upward and forward direction, and acting at the very point where its elevating- and propelling-power is greatest. Compare the axillary and distal curves occurring on the anterior and posterior margins of the wing with those made by the bones of the wing during extension and flexion, as shown in Diagrams from 7 to 16 inclusive, pp. 247, 248, and 249.

Framework or Support for the Wings of the Bird. The Weight of the Bird how utilized in Flight.—In order clearly to comprehend the structure and action of the wing in birds, it will be necessary to advert briefly at this stage to the osseous framework of the wing, and to those portions of the general skeleton more immediately concerned in flight. In the Class Aves, the thoracic vertebræ are more or less completely anchylosed, to give greater rigidity, while the ribs are supplied with lateral processes which gear or chain them together. The cylinder of the thorax is completed by the enormously developed boat-shaped sternum, which gives origin to the powerful pectoral muscles, these, by their action upon the wings, being principally instrumental in elevating and propelling the bird. It may appear a paradox; but those same muscles, because of their great weight (they are sometimes equal to two-thirds of the entire muscular system), tend likewise to depress it; and it is only by their being made to operate upon the wings, which in the

extended state are inclined obliquely upwards (Pl. XIV. figs. 32 & 42), that this tendency to fallin a downward direction is counteracted. The pectoral muscles, therefore, while they raise and carry the body forwards, also confer upon it the requisite degree of steadiness. The manner in which the weight of a living bird is utilized is very remarkable.

In the first place, it gives peculiar efficacy and energy to the down stroke by pressing the inclined planes formed by the wings closely down upon the wind.

Secondly, it adds momentum,—a heavy body, when once fairly under weigh, meeting with little resistance from the air, through which it sweeps like a heavy pendulum.

Thirdly. The mere act of rotating the wings on and off the wind during extension and flexion, with a slight downward stroke, apparently represents the entire exertion on the part of the bird, the rest being performed by weight alone.

This last circumstance is deserving of attention, the more especially as it seems to constitute the principal difference between a living flying thing and an aerial machine. In the latter, as far as yet devised, there is no sympathy between the weight to be lifted and the lifting power, whilst in natural flight the wing and the weight of the bird act together. If an artificial pinion were properly constructed, it would work up to a great extent the inertia of the machine together with the driving power. In other words, the weight, if made to act upon properly constructed inclined surfaces and suitably directed, would in part be converted into actual lifting power.

The Bones of the Wing of the Bird—their articular surfaces, movements, &c.—The humerus, or arm-bone of the wing, is supported by three of the trunk-bones, viz. the scapula or shoulderblade, the clavicle or collar-bone, also called the *furculum* *, and the coracoid bone,—these three converging to form a *point d'appui*, or centre of support for the head of the humerus, which is received in *facettes* or depressions situated on the scapula and coracoid. In order that the wing may have an almost unlimited range of motion and be wielded after the manner of a flail, it is articulated to the trunk by a somewhat lax universal joint, which permits vertical, horizontal, and intermediate movements †. The long axis of the joint is directed vertically, the joint itself somewhat backwards. It is otherwise with the elbow-joint, which is turned forwards, and has its long axis directed horizontally, from the fact that the humerus is twisted upon itself to the extent of nearly a quarter of a turn. The elbow-joint is decidedly spiral in its nature, long axis intersecting that of the shoulder-joint at nearly right angles. The humerus articulates at the elbow with 2 bones, the radius and the ulna, the former of which is pushed from the humerus, while the other is drawn towards it during extension, the

* The furcula are usually united to the anterior part of the sternum by ligament; but in birds of powerful flight, where the wings are habitually extended for gliding and sailing, as in the Frigatebird, the union is osseous in its nature. "In the Frigatebird the furcula are likewise anchylosed with the coracoid bones" (Comp. Anat. & Phys. of Vertebrates, by Prof. Owen, vol. ii. p. 66).

† "The os humeri, or bone of the arm, is articulated by a small rounded surface to a corresponding cavity formed between the coracoid bone and the scapula, in such a manner as to allow great freedom of motion."—*Macgillivray's Brit. Birds*, vol. i. p. 33.

"The arm is articulated to the trunk by a ball and socket-joint, permitting all the freedom of motion necessary for flight." *Cyc. of Anat. & Phys.* vol. iii. p. 424.

reverse occurring during flexion. Both bones, moreover, while those movements are taking place, revolve to a greater or less extent upon their own axes. The bones of the forearm articulate at the wrist with the carpal bones, which being spirally arranged, and placed obliquely between them and the metacarpal bones, transmit the motions to the latter in a curved direction. The long axis of the wrist-joint is, as nearly as may be, at right angles to that of the elbow-joint, and more or less parallel with that of the shoulder. The metacarpal or hand-bones, and the phalanges or finger-bones, are more or less fused together, the better to support the great primary feathers, on the efficiency of which flight mainly depends. They are articulated to each other by double hinge-joints, the long axes of which are nearly at right angles to each other.

As a result of this disposition of the articular surfaces, the wing may be shot out or extended and retracted or flexed in nearly the same plane, the bones composing the wing, particularly those of the forearm, rotating on their axes during either movement.

This secondary action, or the revolving of the component bones upon their own axes, is of the greatest importance in the movements of the wings, as it communicates to the hand and forearm, and consequently to the primary and secondary feathers which they bear, the precise angles necessary for flight; it in fact ensures that the wing, and the curtain or fringe of the wing which the primary and secondary feathers form, shall be screwed into and down upon the wind in extension, and unscrewed or withdrawn from it during flexion. The wing of the bird may therefore be compared to a huge gimlet or auger; the axis of the gimlet representing the bones of the wing, the flanges or spiral thread of the gimlet the primary and secondary feathers. As the degree of rotation made by the bones of the forearm and hand during extension amounts, as nearly as possible, to a quarter of a turn of a spiral, it follows that in flexion the wing presents a knife-like edge to the wind (Plate XIV. fig. 29 *e f*); whereas in extension (*d′ e′ f′*) the curtain of the wing (*c b*) is rotated in a downward direction, until its concave or under surface makes an angle of 30°, or thereabouts, with the horizon*. The angle in question is given at fig. 32, Plate XIV., if a line be drawn from *a* to *e* and another from *a* to *d*, the line *a e* being made to represent the horizon, and the line *a d* the angle which the wing makes with it when fully extended. From this description it will be evident that by the mere rotation of the bones of the forearm and hand the maximum and minimum of resistance is infallibly secured †.

* This is the reverse of what happens in the wing adapted for flying under water (see p. 212).

† The subjoined notes of observations and experiments made by the author on the wing of the Crested Crane, with a view to determine its movements, may prove interesting:—

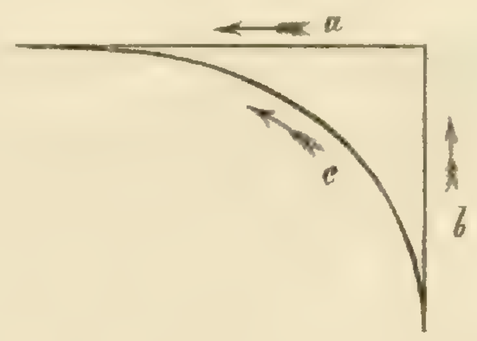
THE MOVEMENTS PECULIAR TO THE ELBOW-, WRIST-, AND OTHER JOINTS IN THE WING OF THE BIRD.

Shoulder-joint.—The head of the humerus is convex and somewhat oval (not round), the long axis of the oval being directed from above downwards, *i. e.* from the dorsal towards the ventral aspect of the bird. The humerus can therefore glide up and down in the *facettes* occurring on the articular ends of the coracoid and scapular bones with great facility, much in the same way that the head of the radius glides upon the distal end of the humerus. But the humerus has another motion; it moves like a hinge from before backwards, and the reverse. The axis of the latter movement is almost at right angles to that of the former. As, however, the shoulder-joint is connected by long ligaments to the body, and can be drawn away from it to the extent of one-eighth of an inch or more, it follows that a third and twisting movement can be performed, the twisting admitting of rotation to the extent of something like a

The Action of the Wing likened by some to that of an Oar.—The effect produced upon the air by the rotating of the wing upon its axis has, I may remark, been likened by many to that produced upon the water by an oar when it is partially rotated (or what is techni-

quarter of a turn. In raising and extending the wing preparatory to the downward stroke, two opposite movements are required, viz. one from before backwards (Diagram 7 *a*), and another from below upwards (*b*). As, however, the axes of these movements are at nearly right angles to each other, the spiral or twisting movement is necessary to run the one into the other—to turn the corner, in fact (*c*).

Diagram 7.



Spiral course (*c*) described by the head of the humerus when the wing is being raised and extended.

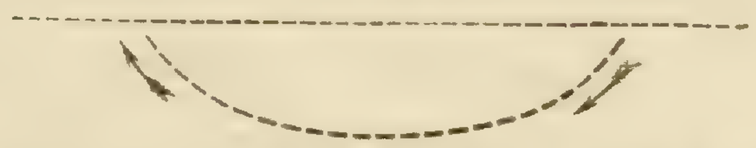
The ligaments of the shoulder-joint are cross or check ligaments, one set acting to prevent an undue elevation and backward motion, the other an undue depression and forward motion. They also act in preventing undue twisting either in a backward or forward direction. The wing of the insect is geared after a similar fashion at the axilla.

Elbow-joint.—The long axis of the elbow-joint intersects the long axis of the shoulder-joint nearly at right angles. When the humerus is fixed, and the wing is extended and flexed, the proximal ends of the bones of the forearm describe a spiral track on the distal end of the humerus or bone of the arm. This is proved by the conformation of the elbow-joint, and by the fact that during extension the elbow and the bones of the forearm, particularly their distal extremities, describe *an upward curve*, so :—

Diagram 8.

During flexion the elbow and bones referred to describe another and opposite curve, as shown in Diagram 9 :—

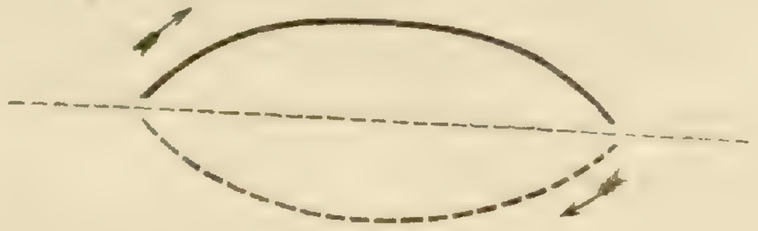
Diagram 9.



The movements described by the elbow-joint during extension and flexion may consequently be represented by an ellipse or ovoid, as under (Diagram 10) :—

Diagram 10.

Extension.



Flexion.

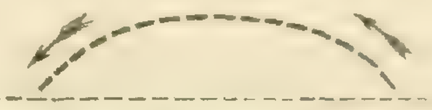
Wrist-joint.—The long axis of the wrist-joint is at nearly right angles to that of the elbow, and nearly parallel with that of the shoulder. In extension of the wrist, the wrist-joint and the metacarpal and phalangeal bones describe *a downward curve*, as at Diagram 11.

Diagram 11.

In flexion the wrist and bones alluded to describe another and opposite curve.

cally called "feathered") between the effective and non-effective strokes. The analogy, however, is more apparent than real, since the *flat of the oar is applied in an opposite direction* to that in which the boat is impelled, whereas the wing is applied *obliquely in the same*

Diagram 12.

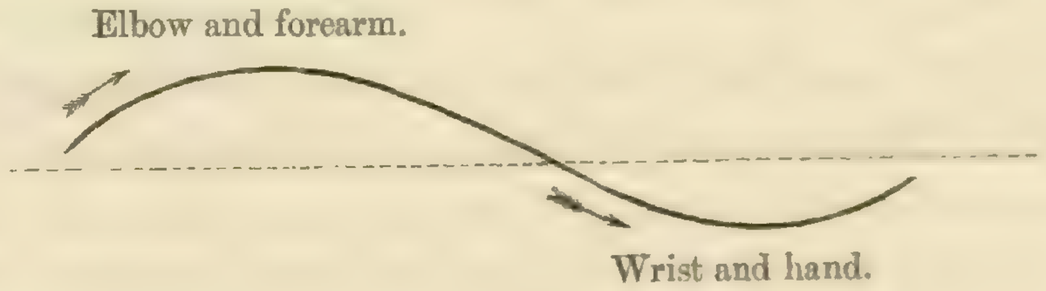


The movements described by the wrist-joint during extension and flexion may therefore be represented as in the adjoining woodcut (Diagram 13).

Diagram 13.

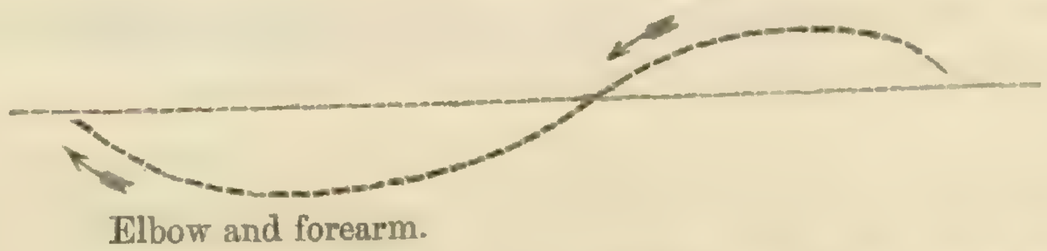
The movements of the wrist-joint are always the reverse of those occurring at the elbow-joint. Thus, during extension, the elbow and bones of the forearm are elevated, and describe one side of an ellipse; while the wrist and bones of the hand are depressed, and describe the side of another and opposite ellipse, as shown at Diagrams 14 & 15.

Diagram 14.—*Extension of the wing.*



These movements, I need scarcely observe, are reversed during flexion.

Diagram 15.—*Flexion of the Wing.*

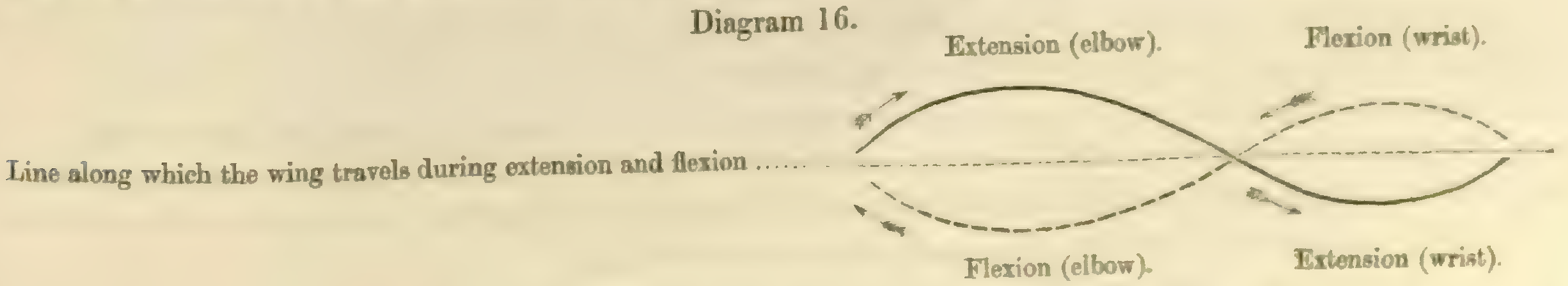


From this it follows that when the elbow is raised *and carried backwards*, the wrist is lowered *and carried forwards*, and *vice versâ*.

Similar remarks may be made regarding the disposition of the articular surfaces, and the movements of the metacarpal and phalangeal bones.

The Elbow-, Wrist-, and other Joints alternate and reciprocate.—The alternating and opposite movements described by the elbow- and wrist-joints are occasioned by the bones of the elbow and wrist being spirally arranged, and from each making a quarter of a turn or so during extension, and the same amount during flexion. As a consequence, the wing, as has been explained in the text, may be shot out or extended, and withdrawn or flexed, in a nearly straight line, the *modus operandi* or principle of action being not inadequately represented by the component parts of an auger or gimlet,—the axis of the instrument representing the action of the wing as a whole, the spiral flanges the movements of the component bones and of the feathers (Diag. 16).

Diagram 16.



Elevation and Depression of the Wing, how caused.—The object of the alternating and reciprocating movements

direction in which the body of the bird is being urged. This additional difference is to be noted: the blade of the oar is applied vertically, or *with its maximum of surface*, during the effective stroke, and horizontally, or with *its minimum of surface*, during the non-effective one; the wing, on the contrary, is *inclined more or less obliquely* both during the down or effective and the up, non-effective, or return stroke. This arises from the fact that the oar simply impels, whereas the wing both impels and elevates.

Function of individual Feathers. The Wing rigid in extension.—While the bones of the forearm and hand are revolving on their own axes during extension, and causing the primary and secondary feathers to make an angle of 30°, or thereabouts, with the horizon (Pl. XIV. figs. 32, 35 & 42), the feathers themselves are likewise rotating on their axes, these being placed obliquely during flexion, to admit of the air passing between them, but gradually presenting their flat surfaces to form an unyielding phalanx and prevent its escape during extension. In extension the wing is rigid, its bones and soft parts being, as it were, screwed home or fixed (Pl. XIV. figs. 30, 31, 41 & 42). The feathers contribute to this result by individually overlapping each other, the primaries and secondaries overlapping each other more and more completely in a direction from without inwards (Pl. XV. figs. 63 and 67, *b a*), these being overlapped by their respective coverts and subcoverts from above downwards (*d e*). The wing in extension is thus balustraded or propped up in every direction; and I am of opinion, as I have already

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of the elbow and wrist is the elevating and depressing of the wing during extension and flexion; the mere act of extension raising the pinion preparatory to its making the downward stroke, the act of flexion gathering the pinion up or off the wind preparatory to a second extension. These movements are analogous in every respect to those made by corresponding parts in the Bat, and by the arms in swimming.

The Elbow-, Wrist-, and other Joints always at nearly right angles.—The long axis of the elbow-, wrist-, and other joints during *extreme extension* is always the reverse of what it is during *extreme flexion*; but whatever the direction of the axis of one joint, the axis of the joint next to it is always nearly at right angles. The joints in this manner coordinate and complement each other. The conformation of the elbow-, wrist-, and other joints, and the movements of the bones of the hand on the forearm, and of the forearm on the humerus, account for the wing of the bird and bat being twisted upon themselves, and for their peculiar spiral mode of action. In the insect, where the wing, as a rule, is not jointed (unless where attached to the body), the spiral twist is impressed on the pinion at first and retained.

Lateral Movements in the Elbow-, Wrist-, and other Joints.—In addition to the movements described by the elbow- and wrist-joints during extension and flexion, a considerable degree of lateral motion is permitted. This is best seen by fixing the humerus, and then rotating the forearm upon it, or by fixing the forearm and rotating the hand upon that.

If the bird be placed with its head away from the spectator, and the forearm be rotated towards him, the motion at the elbow will be found most extensive in *an upward and backward direction*, the reverse of this holding true of the wrist-joint. The same may be said of the metacarpal and phalangeal joints; so that the bones of the hand twist upon the metacarpal, the metacarpal on the carpal, the carpal on the radius and ulna, and the radius and ulna upon the humerus. The alternating spiral arrangement is also manifest in the disposition of the bones of the wing,—the ulna, which is the principal bone of the forearm, curving *from below upwards*, while the metacarpal and phalangeal bones curve *from above downwards*. Advantage is taken of this circumstance to transfer the spiral arrangement obtaining in the osseous structures to the feathers principally employed in flight, the metacarpal and phalangeal bones supporting the primary feathers, the ulna the secondary ones. This coincidence in the arrangement of the bones of the wing and the feathers thereof is necessary, because the bones of the forearm and hand, as has been explained, revolve upon their axes during extension and flexion, and in so doing they rotate the primary and secondary feathers on and off the wind, and give them the precise angles necessary for flight.

It is a curious circumstance that the movements described by the forearm and hand of the bird are analogous to those described by the serpent when creeping and the fish when swimming (Plate XV. fig. 76).

had occasion to state (pages 241, 242, 243, and 244), that the primary, secondary, and tertiary feathers (if allowance be made for a slight degree of elasticity, necessary to prevent shock) do not yield in an *upward* direction during the downward stroke, as many believe *. A reference to Diagram 18 A, p. 253, and to the figures in Plate XIV., all of which are accurately drawn, will be found to corroborate this belief, the uplifting referred to being in every instance quite inappreciable. If the tips of the primary, secondary, and tertiary feathers, did yield, which I am not prepared to admit (see p. 244), they would lose much of the levering power which they undoubtedly possess. To bend, and so permit the air to escape, would be tantamount to removing the fulcrum on which the wing acts. As proof that the feathers do not yield, I may state that I have never observed them give way in the living bird, and that all wings are more or less scooped out on their inferior surface expressly to prevent the escape of the air (Pl. XIV. figs. 28, 31, 32 & 38), the difference in favour of a concave surface over a convex one (Pl. XIV. figs. 35 & 37), when applied to air or water, being as two to one.

The only part where the wind can escape, as I have already pointed out (p. 245), is towards the root of the wing, where the feathers are feeble, and there is a breach naturally (Plate XIV. figs. 28, 30, 35, and 37, *c*). In order to prevent shock and undue straining of the primary and secondary feathers during extension, the bones of the forearm and hand are made to rotate to a slight extent, as already mentioned.

Lax condition of the Pinion in flexion. The imbricating and disimbricating action of the feathers.—The wing, which was rigid or tense during extension, presents an opposite condition during flexion (Plate XIV. figs. 33 & 40), the pinion becoming limp, the feathers losing their bony and fibrous supports, and the wind escaping. Here again, however, there is a limit, the elastic ligament of the wing, which is variously constructed, contracting more or less completely in different birds, the amount of contraction (as has been explained) being regulated by the weight to be supported and by the rapidity with which the wing requires to be driven. In the Swallow *e. g.* (Plate XV. fig. 53), a bird that glides or skims along for great distances, the wing is only very slightly flexed by the elastic ligament, whereas in the Partridge and some of the other Gallinaceous birds it is semiflexed. In the majority of quick-flying birds, where the wing requires to lay hold of the wind and disengage itself suddenly and the birds do not glide or skim, considerable advantage is gained by the primary and secondary feathers being thrown out of position during flexion, this arrangement preventing retardation by diminishing the amount of air displaced in the upward or back stroke. This slating (or overlapping) and unslating action of the feathers during extension and flexion, however, is one of the peculiarities or refinements of flight, and not necessarily an essential feature in it—since flight can be efficiently performed by the insect and bat, where no

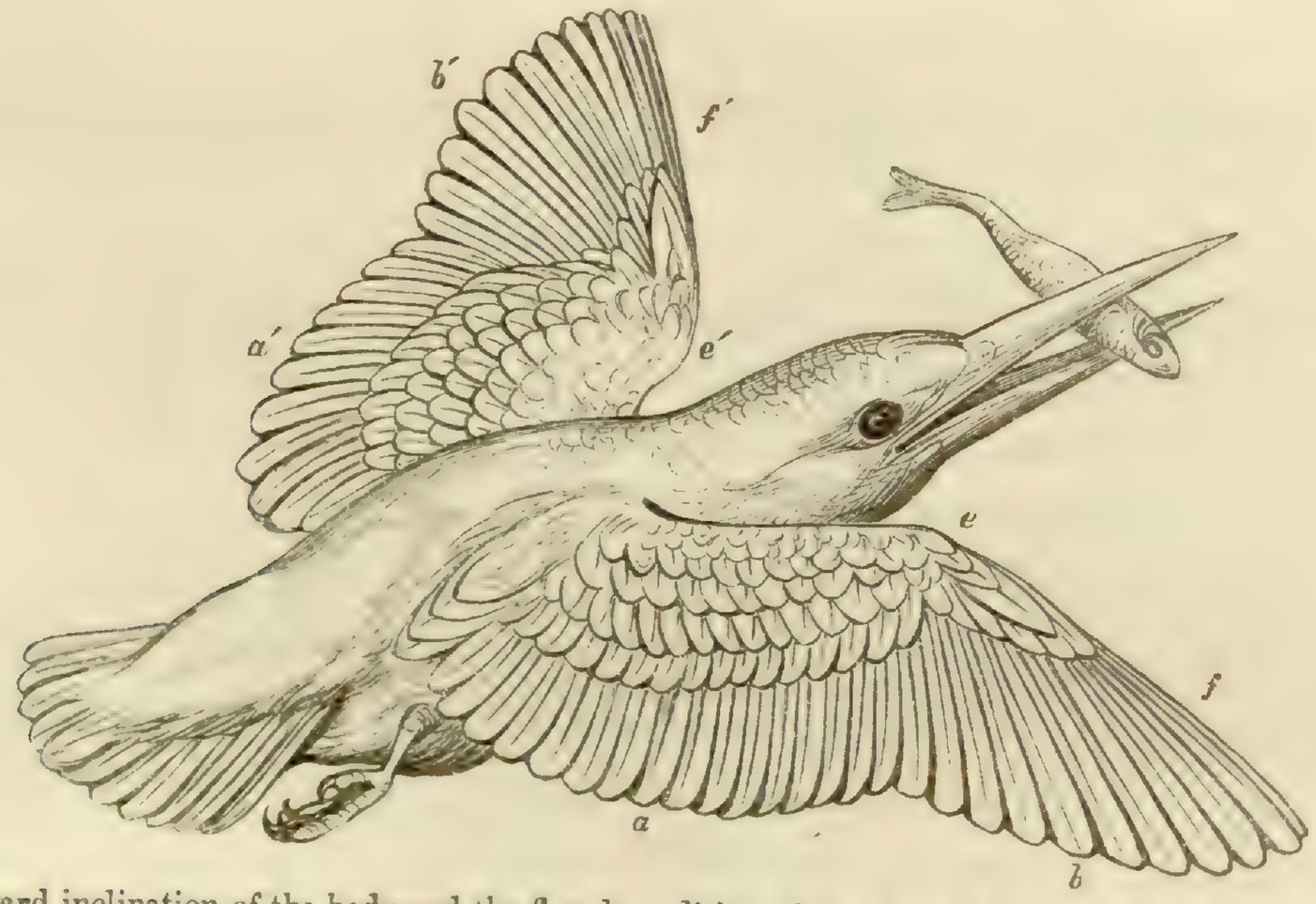
* His Grace the Duke of Argyll, in speaking of the wind compressed in the hollow of the wing, says that, as this cannot pass through the wing "owing to the closing upwards of the feathers against each other," or escape forwards, "because of the rigidity of the bones and of the quills in this direction, it passes backwards, and in so doing *lifts by its force the elastic ends of the feathers.*"—*Reign of Law,* 'Good Words,' February 1865, p. 128.

Mr. Macgillivray would seem to imply a similar belief, in the following passage:—"'To progress in a horizontal direction it is necessary that the downward stroke should be modified *by the elevation in a certain degree of the free extremities of the quills.*"—*Hist. of Brit. Birds,* Lond. 1837, p. 43.

feathers are present, and where, consequently, no opening or closing of them can possibly occur; in some birds, moreover, as the Albatros, which spend the greater part of their time on the wing, the wing-coverts are so numerous and come so low down that the primary and secondary feathers (Plate XV. fig. 64 *b*, *a*) are with difficulty thrown out of position, this being in a great measure unnecessary, as the wings are almost always in the extended state.

Flexion of the Wing necessary to the Flight of Birds.—Considerable diversity of opinion exists as to whether birds do or do not flex their wings in flight. The discrepancy is owing to the great difficulty experienced in analyzing animal movements, particularly when, as in the case of the wings, they are consecutive and rapid. My own opinion is, that the wings are flexed in flight, but that all wings are not flexed to the same extent, and that what holds true of one wing does not necessarily hold true of another. To see the flexing of the wing properly, the observer should be either immediately above the bird or directly beneath it. If the bird be contemplated from before, behind, or from the side, the up and down strokes of the pinion distract the attention and complicate the movement to such an extent as to render the observation of little value. In watching rooks proceeding leisurely against a slight breeze, I have over and over again satisfied myself that the wings are flexed during the up stroke, the mere extension and flexion, with very little of a down stroke, in such instances sufficing for propulsion. I have also observed it in the Pigeon in full flight, and likewise in the Starling, Sparrow, and Kingfisher.

Diagram 17.



Shows the upward inclination of the body and the flexed condition of the wings (*a b*, *e f*) in the flight of the Kingfisher.

It seems to occur principally at the wrist-joint, and gives to the wing the peculiar quiver or tremor so apparent in rapid flight, and which is likewise well seen in young birds at feeding-time. The object to be attained is manifest. By the flexing of the wing in flight, the "*remiges*," or rowing-feathers, are opened up or thrown out of position, and the wind permitted to escape—advantage being thus taken of the peculiar action of the individual feathers and the higher degree of differentiation perceptible in the wing of the bird as compared with that of the bat and insect.

In order to corroborate the above opinion, I extended the wings of several birds as in

rapid flight, and fixed them in the outspread position by lashing them to light unyielding reeds. In these experiments the shoulder and elbow-joints were left quite free—the wrist or carpal and the metacarpal joints only being bound. I took care, moreover, to interfere as little as possible with the action of the elastic ligament or alar membrane which, in ordinary circumstances, recovers or flexes the wing, the reeds being attached for the most part to the primary and secondary feathers. When the wings of a pigeon were so tied up, the bird could not rise, although it made vigorous efforts to do so. When dropped from the hand, it fell violently on the lawn, notwithstanding the strenuous exertions which it made with its pinions to save itself. When thrown into the air, it fluttered most energetically in its endeavours to reach the dove-cot, which was close at hand; in every instance, however, it fell, more or less heavily, the distance attained varying with the altitude to which it was projected.

Thinking that probably the novelty of the situation and the strangeness of the appliances confused the bird, I allowed it to walk about and to rest without removing the reeds. I repeated the experiment at intervals, but with no better results. The same phenomena, I may remark, were witnessed in the Sparrow; so that I think there can be little doubt that a certain degree of flexure is indispensable to the flight of all birds—the amount varying according to the length and form of the pinion, and being greatest in the short-broad-winged birds, as the Partridge (Plate XIV. fig. 32) and Kingfisher (Diagram 17, p. 252), less in those whose wings are moderately long and narrow, as the Gulls (Diagram 18 A, B, C) and many of the oceanic birds, and least in the heavy-bodied long- and narrow-winged sailing or gliding birds, the best example of which is the Albatros (Diagram 18 D). The degree of flexion, moreover, varies according as the bird is rising, falling, or progressing in a horizontal direction, it being greatest in the two former, and least in the latter.

Diagram 18.

Illustrates the twisted conformation (*a' b', d' e' f'*) and slightly flexed condition of the pinion in the flight of the Gull (A, B, C); also the narrow, rigid, and widely-extended pinions of the Albatros (D) and other sailing birds.

It is true that in insects, unless perhaps in those which fold or close the wing during repose, no flexion of the pinion takes place in flight; but this is no argument against this mode of diminishing the wing-area during the up or back stroke where the joints

exist; and it is more than probable that when joints are present they are added to augment the power of the wing during its active state, *i. e.* during flight, quite as much as to assist in arranging the pinion on the back or side when the wing is passive and the animal is reposing. The flexion of the wing is most obvious when the bird is exerting itself, and may be detected in birds which skim or glide when they are rising, or when they are vigorously flapping their wings to secure the impetus necessary to the gliding movement. It is less marked at the elbow-joint than at the wrist; and it may be stated generally that, as flexion *decreases*, the twisting flail-like movement of the wing at the shoulder *increases*, and *vice versâ*,—the great difference between sailing birds (see Diagram 18 D, p. 253, and Diagram 19, p. 259) and those which do not sail (Diagram 17, p. 252) amounting to this, that in the sailing birds the wing is worked from the shoulder by being alternately rolled on and off the wind, as in insects; whereas, in birds which do not glide, the spiral movement travels along the arm as in bats, and manifests itself during flexion and extension in the bending of the joints and in the rotation of the bones of the wing on their axes. The spiral conformation of the pinions, to which allusion has been so frequently made, is best seen in the heavy-bodied birds, as the Turkey, Capercailzie, Pheasant, and Partridge (Plate XV. fig. 70); and here also the concavo-convex form of the wing is most perceptible (Plate XIV. figs. 31 and 32). In the light-bodied, ample-winged birds, the amount of twisting is diminished (Diagram 18 A. *a′ b′, d′ e′ f′*, p. 253), and, as a result, the wing is more or less flattened (Plate XIV. figs. 29 and 30).

Power of the Wing—to what owing.—The shape and power of the pinion depend upon one of three circumstances—to wit, the length of the humerus*, the length of the cubitus or forearm, and the length of the primary feathers. In the Swallow the humerus, and in the Humming-bird the cubitus is very short, the primaries being very long; whereas in the Albatros the humerus or arm-bone is long and the primaries short. When one of these conditions is fulfilled, the pinion is usually greatly elongated and scythe-like (Plate XIV. fig. 35, Plate XV. fig. 64)—an arrangement which enables the bird to keep on the wing for immense periods with comparatively little exertion, and to wheel, turn, and glide about with exceeding ease and grace. When the wing is truncated and rounded, a form of pinion usually associated with a heavy body, as in the Grouse, Quail, Diver, and Grebe, the muscular exertion required and the rapidity with which the wing moves are very great, those birds, from a want of facility in turning, flying either in a straight line or making large curves. They, moreover, rise with difficulty, and alight clumsily and somewhat suddenly. Their flight, however, is perfect while it lasts.

The Goose (Plate XIV. fig. 42) and Duck (Plate XIV. fig. 37), Pigeon (Plate XIV. fig. 33) and Crow (Plate XIV. figs. 41 and 43), are intermediate both as regards the form of the wing and the rapidity with which it is moved.

The Heron (Plate XIV. fig. 38) and Humming-bird, furnish extreme examples in another direction,—the Heron having a large wing with a leisurely movement, the Humming-bird a comparatively large wing with a greatly accelerated one.

* "The humerus varies extremely in length, being very short in the Swallow, of moderate length in the Gallinaceous birds, longer in the Crows, very long in the Gannets, and unusually elongated in the Albatros. In the Golden Eagle it is also seen to be of great length."—*Macgillivray's British Birds*, vol. i. p. 30.

But I need not multiply examples; suffice it to say that, unless in the case of the sailing birds, which are exceptional, flight may be attained within certain limits by every size and form of wing, if the number of its oscillations be increased in proportion to the weight to be raised.

Reasons why the Effective Stroke should be delivered Downwards and Forwards.—The wings of all birds, whatever their form, act by alternately presenting oblique and comparatively non-oblique surfaces to the air,—the mere extension of the pinion, as has been shown, causing the primary, secondary, and tertiary feathers to roll down till they make an angle of 30° or so with the horizon, in order to prepare it for giving the effective stroke, which is delivered, with great rapidity and energy, in a *downward* and *forward* direction. I repeat, "downward and forward;" for a careful examination of the relations of the wing in the dead bird, and a close observation of its action in the living one, have fully convinced me that the stroke is invariably delivered in this direction*. If the wing did not strike downwards and *forwards*, it would act at a manifest disadvantage:—

1st. Because it would present the back or convex surface of the wing to the air—a convex surface dispersing or dissipating the air, while a concave surface gathers it together or focuses it.

2nd. In order to strike backwards effectually, the concavity of the wing would also require to be turned backwards; and this would involve the depression of the anterior or thick margin of the pinion, and the elevation of the posterior or thin one, during the down stroke, which never happens.

3rd. The strain to which the pinion is subjected in flight would, if the wing struck *backwards*, fall, not on the anterior or strong margin of the pinion formed by the bones and muscles, but on the posterior or weak margin formed by the tips of the primary, secondary, and tertiary feathers—which is not in accordance with the structure of the parts.

* *Prevailing Opinions as to the Direction of the Down Stroke.*—Mr. Macgillivray, in his 'History of British Birds,' published in 1837, expresses a contrary belief. He says (p. 34) that in flexion the wing is drawn upwards, forwards, and inwards, but that during extension, when the effective stroke is given, it is made to strike outwards, downwards, and *backwards*. The Duke of Argyll holds a very similar opinion. In speaking of the hovering of birds, he states that, "if a bird, by altering the axis of its own body, can direct its wing-stroke in some degree *forwards*, it will have the effect of *stopping* instead of promoting progression;" and that, "Except for the purpose of *arresting* their flight, birds can never strike except *directly downwards*—that is, directly against the opposing force of gravity."—*Good Words*, Feb. 1865, p. 132.

Mr. Bishop, in the 'Cyc. of Anat. & Phys.' vol. iii. p. 425, says, "In consequence of the planes of the wings being disposed either *perpendicularly* or *obliquely backwards* to the direction of their motion, a corresponding impulse is given to their centre of gravity." Professor Owen, in like manner, avers that "a downward stroke would only tend to raise the bird in the air; to carry it forwards, the wings require to be moved in an oblique plane, so as to *strike backwards* as well as downwards."—*Comp. Anat. and Phys. and Vertebrates*, vol. ii. p. 115.

The following is the account given by M. E. Liais:—"When a bird is about to depress its wing, this is a little inclined from before backwards. When the descending movement commences, the wing does not descend parallel to itself in a direction from before backwards; but the movement is accompanied by a rotation of several degrees round the anterior edge, so that the wing becomes more in front than behind, and *the descending movement is transferred more and more backwards*. * * * * * When the wing has completely descended, it is both *further back* and lower than at the commencement of the movement."—*On the Flight of Birds and Insects, Annals of Nat. Hist.* vol. xv. 3rd series, p. 156.

4th. The feathers of the wing, instead of being closed, as they necessarily are, by a *forward* and downward movement, would be inevitably opened, and the integrity of the wing impaired by a downward and *backward* movement.

5th. The disposition of the articular surfaces of the wing (particularly that of the shoulder-joint) is such as to facilitate the downward and *forward* movement, while it in a great measure prevents the downward and *backward* one.

6th and lastly. If the wing did in reality strike downwards and *backwards*, a result the converse of that desired would most assuredly be produced, it always happening that an oblique surface which smites the air in a downward and *backward* direction (if left to itself) tends to depress the body bearing it. This is proved by the action of free inclined planes, arranged in the form of a screw, upon the air. If a small light screw be placed horizontally in a rest and set free by a rapid rotatory movement, it will be found that, so long as the blades are directed upwards and they are made to strike *forwards*, or in the direction of the inclination of the blades, the machine will rise. If, however, no change be made in the direction of the blades, and they are made to strike *backwards*, *i. e.* in the direction of the lower margins of the blades, no rising of the machine will occur. Further, the screw if left to itself, invariably acts in opposite directions during its ascent and descent. If a screw, *e. g.*, rises by having its blades inclined in an upward direction from *right to left*, and by being driven in this direction, it descends by rotating from *left to right*, the mere change in the direction of the rotation causing the blades to strike *downwards* instead of *upwards*. The effect produced by the downward and *backward* stroke of an oblique surface upon the air, if its nether margin is directed downwards and backwards, as is the case in the wing of the bird, would consequently be to depress the body of the bird. The reverse of this, as I pointed out at pp. 212, 213, and 214, holds true of oblique surfaces acting on the water.

Analogy between the Wing and a Boy's Kite.—The wing strikes the air precisely as a boy's kite would if it were jerked by its string, the only difference being that the kite is *pulled forwards* upon the wind by the string and the hand (Plate XV. figs. 71 and 72, *r s*); whereas in the insect, bat, and bird the wing is *pushed forwards* on the wind by the weight of the body and the power residing in the pinion itself*. When the wing of the bird descends it makes a variable angle with the body in addition to the angle which it makes with the horizon, so that in this direction also it acts as an inclined plane and levers the body upwards. When, moreover, it is being recovered or flexed preparatory to making a new stroke, it is drawn from below upwards and from before backwards, the angle which was made by the curtain of the wing with the horizon during extension being gradually diminished.

The Wing acts as an Elevator, Propeller, and Sustainer, both during Extension

* Since I gave the above explanation of the action of the wing (Proceedings of the Royal Institution of Great Britain, March 1867), Mr. Reda St. Martin has constructed a model with a view to testing the efficacy of this principle in artificial flight. It consists of an ordinary kite with two screws situated near its upper and central part, the axes of which are at right angles to the plane of the kite and the plane of progression. The screws are made to revolve with their blades turned in a downward direction, the idea being to force the kite down upon the wind from behind. This result would, however, be secured by the inertia of the machine, independently of the screws.

and Flexion.—The wing, as has been explained, is recovered or drawn off the wind principally by the contraction of the elastic ligament extending between the joints, so that the pinion during flexion enjoys a certain degree of repose. The time occupied in recovering is not lost so long as the wing makes an angle with the horizon and the bird is in motion, it being a matter of indifference whether the wing acts on the air, or the air on the wing, so long as the body bearing the latter is under weigh; and this is perhaps the chief reason why the Albatros, which is a very heavy bird *, can sail about for such incredible periods without apparently moving the wings at all. Captain Hutton thus graphically describes the sailing of this magnificent bird:—"The flight of the Albatros is truly majestic, as with outstretched motionless wings he sails over the surface of the sea—now rising high in air, now with a bold sweep, and wings inclined at an angle with the horizon, descending until the tip of the lower one all but touches the crest of the waves as he skims over them"†.

The wing of the bird may therefore be said to act in four different ways:—

1st, during extension, when it gradually makes an angleof 30°, or thereabouts, with the horizon.

2nd, during the downward stroke, when it maintains, or nearly maintains, the angle of 30° with the horizon, and makes a variable angle with the body.

3rd, during flexion, when the angle made by the wing with the horizon is reduced, preparatory to making the return stroke.

4th, during the return or up stroke, when the pinion acts at a gradually decreasing angle, in virtue of its being carried against the wind by the body of the bird which is in motion. The wing, as will be seen from this account, acts as a *sustainer and partial elevator* during its ascent, by being passively forced against the wind by the momentum acquired by the mass bearing it.

Birds of Flight separable into four kinds.—Birds of flight may be conveniently divided into four kinds:—

1st, such as have heavy bodies and short wings with a rapid movement (Plate XIV. figs. 31 and 32).

2nd, such as have light bodies and large wings with a leisurely movement (Plate XIV. fig. 38).

3rd, such as have heavy bodies and long narrow wings with a decidedly slow movement (Diagram 18 D, p. 253; Diagram 19, p. 259); and

4th, such as are intermediate with regard to the size of body, the dimensions of wing, and the energy with which it is driven (Plate XIV. fig. 30).

They may be subdivided into those which float, skim, or glide (Plate XIV. fig. 28), and those which fly in a straight line (Plate XIV. figs. 31, 37 and 42) and irregularly (Plate XIV. figs. 36 and 39).

The Pheasant, Partridge (Plate XIV. figs. 31 and 32), Grouse, and Quail furnish good examples of the heavy-bodied, short-winged birds. In these the wing is rounded and deeply concave. It is, moreover, wielded with immense velocity and power.

* The average weight of the Albatros, as given by Gould, is 17 lbs.—*Ibis*, 2nd series, vol. i. 1865, p. 295.

† "On some of the Birds inhabiting the Southern Ocean," by Capt. F. W. Hutton, 'Ibis,' 2nd series, vol. i. 1865, p. 282.

The Heron (Plate XIV. fig. 38), Seamew, Lapwing (Plate XIV. fig. 29), and Owl (Plate XIV. fig. 30) supply examples of the second class, where the wing, as compared with the body, is very ample, and where consequently it is moved more leisurely and less energetically. The Albatros (Diagram 18 D, p. 253) and Pelican furnish instances of the third class, embracing the heavy-bodied, long-winged birds.

The Duck (Plate XIV. fig. 37), Pigeon (Plate XIV. figs. 33 and 40), Crow (Plate XIV. figs. 41 and 43) and Thrush are intermediate, both as regards the size of the wing and the rapidity with which it is made to oscillate.

The Albatros (Diagram 18 D, p. 253), Swallow, Eagle, and Hawk (Plate XV. fig. 60) furnish instances of sailing or gliding birds, where the wing is ample, elongated, and more or less pointed, and where advantage is taken of the weight of the body and the shape of the pinion to utilize the air as a supporting medium. In these the pinion acts as a long lever *, and is wielded with great precision and power, particularly at the shoulder.

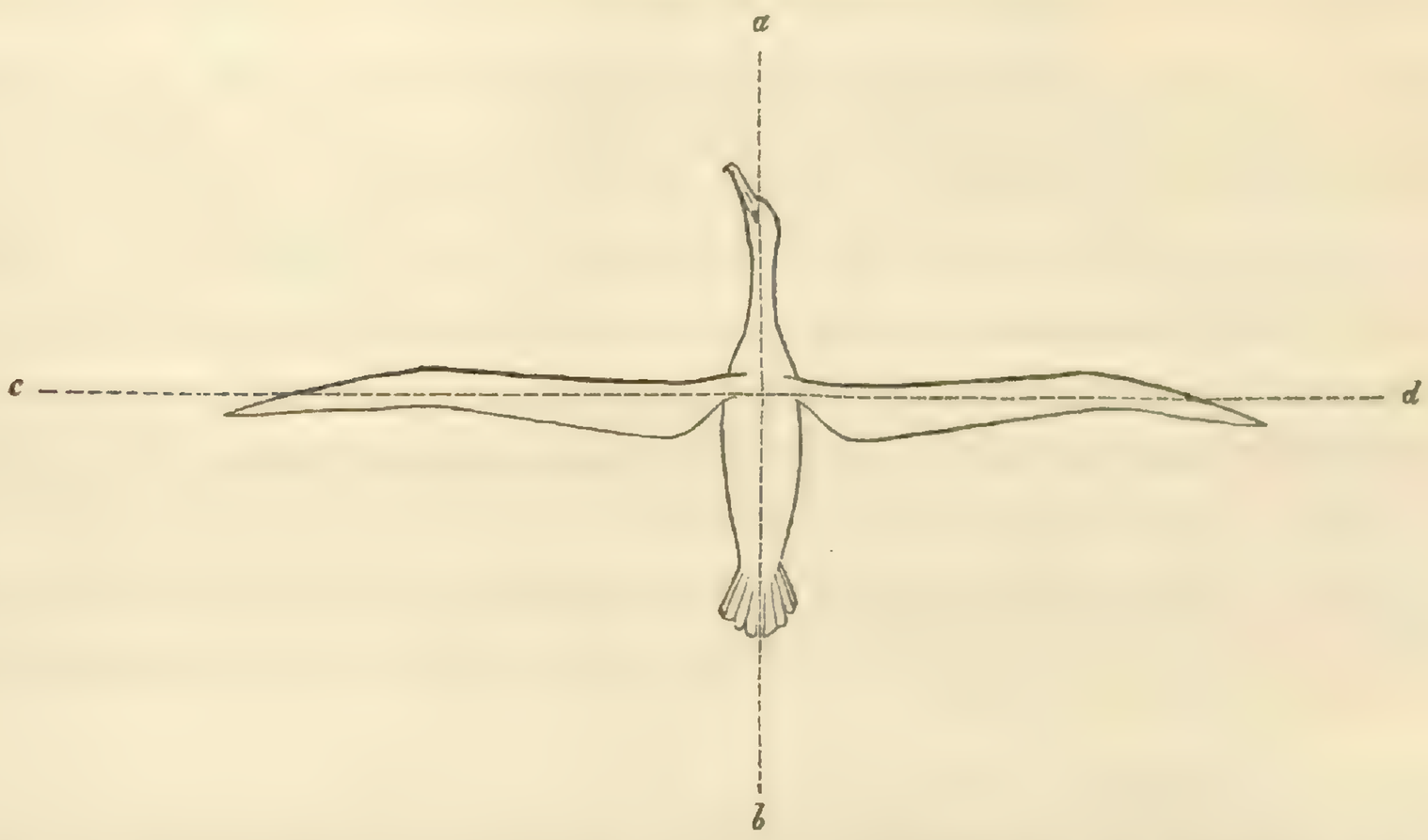
The Flight of the Albatros compared to the Movements of a Compass set upon Gimbals.—A careful examination of the movements in skimming birds has led me to conclude that by a judicious twisting or screw-like action of the wings at the shoulder, in which the pinions are alternately advanced towards and withdrawn from the head in a manner analogous to what occurs at the pelvis in skating without lifting the feet, birds of this order can not only maintain the motion which they secure by a few energetic flappings, but, if necessary, actually increase it, and that without either bending the wing or beating the air.

The twisting or screwing forward and backward action of the pinion referred to in no way interferes, I may remark, with the rotation of the wing on its long axis, the pinion being carried forward and rotated down upon the wind during extension, and retracted or drawn back and rotated off the wind during flexion. The terms "extension" and "flexion," I ought to observe, are here used in the sense in which I employed them when speaking of the pinion of the insect (p. 226). As the movements described enable the sailing bird to tilt its body from before backwards, or the reverse, and from side to side or laterally, it may be represented as oscillating on one of two centres, as shown in the subjoined woodcut (Diagram 19, p. 259), the one corresponding with the long axis of the body

* *Advantages possessed by long Pinions.*—The long narrow wings are most effective as elevators and propellers, from the fact (pointed out by Mr. Wenham) that at high speeds, with very oblique incidences, the supporting effect becomes transferred to the *front edge* of the pinion. It is in this way "that the effective propelling area of the two-bladed screw is tantamount to its entire circle of revolution." A similar principle was announced by Sir George Cayley upwards of fifty years ago. "The stability in this position, arising from the centre of gravity being below the point of suspension, is aided by a remarkable circumstance that experiment alone could point out. *In very acute angles with the current*, it appears that the centre of resistance in the sail does not coincide with the centre of its surface, *but is considerably in front of it*. As the obliquity of the current decreases, these centres approach, and coincide when the current becomes perpendicular to the plane; hence any heel of the machine backwards or forwards removes the centre of support behind or before the point of suspension."—*Nicholson's Journal*, vol. xxv. p. 83. When the speed attained by the bird is *greatly accelerated*, and *the stratum of air passed over in any given time enormously increased*, the support afforded by the air to the inclined planes formed by the wings *is likewise augmented*. This is proved by the rapid flight of skimming or sailing birds when the wings are moved at long intervals and very leisurely. The same principle supports the skater as he rushes impetuously over insecure ice, and the thin flat stone projected along the surface of still water. The velocity of the movement in either case prevents sinking by not giving the supporting particles time to separate.

(Diagram 19 *a b*), the other with the long axis of the wings (*c d*). Between these two extremes every variety of sailing and gliding motion which is possible in the mariner's

Diagram 19. Albatros.



compass when set upon gimbals may be performed; so that a skimming or sailing bird may be said to possess perfect command over itself and over the element in which it moves.

Captain Hutton, to whose spirited narrative I have already had occasion to allude, makes the following remarkable statement regarding the Albatros :—" I have sometimes watched narrowly one of these birds sailing and wheeling about in all directions for more than an hour, without seeing the slightest movement of the wings, and have never witnessed anything to equal the ease and grace of this bird as he sweeps past, often within a few yards, every part of his body perfectly motionless except the head and eye, which turn slowly and seem to take notice of everything" *.

" Tranquil its spirit seem'd and floated slow;
Even in its very motion there was rest "†.

As an antithesis to the apparently lifeless wings of the Albatros, the ceaseless activity of those of the Humming-bird might be adduced. In those delicate and exquisitely beautiful birds, the wings, according to Mr. Gould, move so rapidly when the bird is poised before an object that it is impossible for the eye to follow each stroke, and a hazy circle of indistinctness on each side of the bird is all that is perceptible. When the Humming-bird flies in a horizontal direction, it occasionally proceeds with such velocity as altogether to elude observation.

The regular and irregular in Flight.—The Coot, Diver, Duck, and Goose fly with great regularity in nearly a straight line and with immense speed; they never skim nor glide, their wings being too small for this purpose. The Woodpecker, Magpie, Fieldfare and Sparrow supply examples of what may be termed the "irregular" in flight. These, as is well known, fly in curves of greater or less magnitude, by giving a few vigorous strokes and then desist-

* "On some of the Birds inhabiting the Southern Ocean," 'Ibis,' 2nd series, vol. i. 1865.

† Professor Wilson's Sonnet, "A Cloud," &c.

ing, the effect of which is to project them along a series of parabolic curves. The Snipe (Plate XIV. fig. 36) and Woodcock are irregular in another respect, their flight being sudden, jerky, and from side to side.

Mode of ascending, descending, turning, &c.—All birds which do not, like the Swallow and Humming-birds, drop from a height, raise themselves at first by a vigorous leap (Plate XIV. fig. 43), in which they incline their bodies in an upward direction (Plate XIV. figs. 32, 35, and 42), the height thus attained enabling them to extend and depress their wings without injury to the feathers. By a few sweeping strokes delivered downwards and forwards, in which the wings are made nearly to meet above (Plate XIV. fig. 43) and below (Plate XIV. fig. 41) the body, they lever themselves upwards and forwards, and in a surprisingly short space of time acquire that degree of momentum which greatly assists them in their future career*. In rising from the ground, as may readily be seen in the Crow, Pigeon, and Kingfisher (Diagram 17, p. 252), the tail is expanded and the neck stretched out, so that the body is converted into an inclined plane and acts mechanically as a glider. The centre of gravity and the position of the body are changed at the will of the animal by the play of the wings, aided by the long flexible neck, feet, and tail; and when it wishes merely to progress, it assumes a more or less horizontal position, well seen in the Wild Duck in full flight (Diagram 4, p. 210). When the bird has elevated itself to the desired height, the length of the downward stroke is generally curtailed, the mere extension and flexion of the wing, assisted by the weight of the body, in some cases sufficing for the

* *Weight, Momentum, and Power, to a certain extent synonymous in flight.*—When a bird rises it has little or no momentum, so that if it came in contact with a solid resisting surface it would not injure itself. When, however, it has acquired all the momentum of which it is capable, and is in full and rapid flight, such contact results in destruction. My friend Mr. A. D. Bartlett informed me of an instance where a wild duck terminated its career by coming violently in contact with one of the glasses of the Eddystone lighthouse. The glass, which was fully an inch in thickness, was completely smashed. Advantage is taken of this circumstance in killing sea-birds, a bait being placed on a board and set afloat with a view to breaking the neck of the bird when it stoops to seize the carrion. The additional power due to momentum in heavy bodies in motion is well illustrated in the start and progress of steamboats. In these the *slip*, as it is technically called, decreases as the speed of the vessel increases, the strength of a man, if applied by a hawser attached to the stern of a moderate-sized vessel, being sufficient to retard, and, in some instances, prevent its starting. In such a case the power of the engine is entirely devoted to "slip" or in giving motion to the fluid in which the screw or paddle is immersed. It is consequently not the power residing in the paddle or screw which is cumulative, but the momentum. In the bird, the momentum is made to act upon the inclined planes formed by the wings (Plate XIV. figs. 32, 35, and 42), these adroitly converting it into an elevating- and propelling-power. It is to this circumstance, more than any other, that the prolonged flight of birds is mainly due, the inertia or dead weight of the trunk aiding and abetting the action of the wings, and so relieving the excess of exertion which would necessarily devolve on the bird. It is thus that the power which in living structures resides in the mass is conserved, and the mass itself turned to account. But for this reciprocity, no bird could retain its position in the air for more than a few minutes at a time. This is proved by the comparatively brief upward flight of the Lark and the hovering of the Hawk when hunting. In both these cases the body is exclusively sustained by the action of the wings, the weight of the trunk taking no part in it; in other words, the weight of the body does not contribute to flight by adding its momentum and the impulse which momentum begets. In the flight of the Albatros, on the other hand, the momentum does the principal portion of the work, the wings for the most part being simply rotated on and off the wind to supply the proper angles necessary for the inertia or mass to operate upon. It appears to me that in this blending of active and passive power the mystery of flight is wrapped up, and that no arrangement will succeed in producing flight artificially which does not recognize and apply the principle here pointed out.

ordinary purposes of flight. This is especially the case if the bird is advancing against a slight breeze, the effort required under such circumstances being nominal in amount. That little power is expended in such instances is proved by the endless gyrations of Rooks and other birds, these being continued for hours together. In birds which glide or skim, it has appeared to me that the wing is recovered much more quickly and the downward stroke delivered more slowly than in ordinary flight—in fact, that the rapidity with which the wing acts in an upward and downward direction is, in some instances, more or less reversed; and this is what we should naturally expect if we recollect that in gliding the wings require to be, for the most part, in the expanded condition. If this observation be correct, it follows that birds have the power of modifying the duration of the up and down stroke at pleasure. Although the wing of the bird usually strikes the air at an angle of 30° or so, that angle may be increased to such an extent as to assist in reversing the position of the bird, as happens in the Tumbler Pigeon, which can, by slewing its wings forwards and suddenly throwing back its head, turn a somersault. When birds are fairly on the wing they have the air, unless when that is greatly agitated by a storm, completely under control. This arises from their greater specific gravity, and because they are possessed of independent motion. If they want to turn, they have simply to tilt their bodies laterally, as a railway carriage would be tilted in taking a curve*, or to increase the number of beats given by the one wing† as compared with the other, or to keep the one wing extended while the other is partially flexed. The neck, feet, and tail may or may not contribute to this result‡. If the bird wishes to rise, it tilts its entire body (the neck and tail participating) in an upward direction (Diagram 17, p. 252); or it rises principally by the action of the

* Captain F. W. Hutton, in speaking of the Albatros, says, "If he wishes to turn to the right he bends his head and tail slightly upwards, at the same time raising his left side and wing, and lowering the right in proportion to the sharpness of the curve he wishes to make, the wings being kept quite rigid the whole time. To such an extent does he do this, that, in sweeping round, his wings are often pointed in a direction nearly perpendicular to the sea; and this position of the wings, more or less inclined to the horizon, is seen always and only when the bird is turning."—*On some of the Birds inhabiting the Southern Ocean*, '*Ibis*,' 2nd series, vol. i. 1865, p. 227.

† "The turning in flight to the right or left is principally effected by an inequality in the vibrations of the wings. To wheel to the right, the left wing must be plied with greater frequency or force, and *vice versâ*."—*Comp. Anat. & Phys. of Vertebrates*, by Professor Owen, vol. ii. p. 115. Mr. Macgillivray, as will be seen from the following passage, hold an opposite opinion. "Birds in flying always beat their wings synchronously, never alternately, even *in executing rapid turns*, which are effected by the contraction of the one wing and the extension of the other, *aided by the tail*."—*Macgillivray, l. c.* vol. i. p. 420. The Duke of Argyll does not admit the rudder-like action of the tail, and states that, "if the tail had been intended as a rudder, its vane would have been set, not as it is, horizontally, but perpendicularly to the line of flight."—'*Good Words*' for February 1865, p. 132. Although the tail of the bird is expanded horizontally or laterally, and not vertically, as is the rudder, it ought not to be overlooked that the muscles of the tail are arranged in such a manner as to admit of its being tilted on either side, as happens in the tail of the Whale, Dugong, Manatee, Porpoise, and Beaver, and that when so tilted it materially assists in wheeling. Further, it does not follow, because a bird can fly without a tail or with a very small one, that the evolutions of the bird are not facilitated by its presence. On the contrary, the birds which are most remarkable for the rapidity and precision of their movements (say the birds of prey) are usually provided with this organ in perfection. The absence of an organ, moreover, is no proof of its utility when present.

‡ The tail is supplied with muscles to spread the feathers and to elevate and depress them, as well as to tilt them obliquely. "The tail-feathers may be extremely short, short, moderate, long, extremely long, and of all intermediate gradations, even, rounded, graduated, or wedge-shaped at the end, and tapering, pointed, emarginate or forked."—*Macgillivray, l. c.* vol. i. p. 83.

wings and by muscular efforts, as happens in the Lark. The bird can in this manner likewise retain its position in the air, as may be observed in the Hawk when hovering above its prey (Plate XV. fig. 60). If birds wish to descend, they may reverse the direction of the inclined plane and plunge head foremost with extended wings (Plate XIV. figs. 34 and 36); or they may flex the wing (Plate XIV. fig. 33), and so accelerate their pace; or they may raise their wings and drop parachute-fashion (Plate XIV. figs. 39 and 40); or they may even fly in a downward direction—a few sudden strokes, a more or less abrupt curve, and a certain degree of horizontal movement being in either case necessary to break the fall previous to alighting. Birds which fish on the wing, as the Osprey and Gannet, precipitate themselves from incredible heights and drop into the water with the velocity and power of a cannon-ball—the momentum which they acquire during their descent materially aiding them in their subaqueous flight. They emerge from the water and are again upon the wing before the eddies occasioned by their precipitous descent have well subsided, in some cases rising apparently without effort, and in others running along and beating the surface of the water for a brief term with their pinions and feet.

The Flight of Birds referable to Muscular Exertion and Weight.—The various movements involved in ascending, descending, wheeling, gliding, and progressing horizontally are all the result of muscular power and weight, properly directed and acting upon appropriate surfaces—that apparent buoyancy in birds which we so highly esteem arising not from superior lightness, but from their possessing that degree of solidity which enables them to subjugate the air,—weight and independent motion, *i. e.* motion associated with animal life, or what is equivalent thereto, being the two things indispensable in sucessful aerial progression. The weight in insects and birds is in great measure owing to their greatly developed muscular system, this being in that delicate state of tonicity which enables them to act through its instrumentality with marvellous dexterity and power, and to expend or reserve their energies, which they can do with the utmost exactitude, in their apparently interminable flights. As space will not admit of my going into the muscular arrangements of birds, I may state, as has been already partly done (pp. 200, 201, and 202), that this branch of the subject would lose much of its intricacy, if, instead of regarding the muscular system of the wing as an aggregation of flexor, extensor, abductor, adductor, pronator, and supinator muscles, we were to regard it as consisting of a series of muscular cycles or rings with the bones and intervening joints as their diameters,—contraction on the one aspect of the circle, whether above, below, or at the sides of the bone, being accompanied by relaxation on the other, the bones and joints, which may be regarded as oscillating within the muscular cycles, making the muscular efforts apparent by the flexion, extension, and the upward and downward movements of the pinion *.

* This view, as has been explained, is rendered probable by the fact that in the more elementary combinations of muscles, as in the heart, stomach, bladder, and uterus, and in the *vermes* and leeches, the muscular fibres are spirally arranged and are continuous upon themselves—and because the sclerous or bony parts in the higher orders of animals are added as supports, and are by no means essential to motion. It is, moreover, next to impossible to determine the peculiar action of any one muscle on any one part, as the aspect of the limb on which it occurs may, and very pro-

Lifting-capacity of Birds.—The muscular power in birds is usually greatly in excess, particularly in birds of prey, as *e. g.* the Condors, Eagles, Hawks, and Owls. The Eagles are remarkable in this respect,—these having been known to carry off young deer, lambs, rabbits, hares, and, it is averred, even young children. Many of the fishing birds, as the Pelicans and Herons, can likewise carry considerable loads of fish*; and even the smaller birds, as the records of spring will show, are capable of transporting comparatively large twigs for building-purposes. I myself have seen an Owl, which weighed a little over 10 ounces, lift $2\frac{1}{2}$ ounces, or a quarter of its own weight, without effort after having fasted twenty-four hours; and a friend informs me that, a short time ago, a splendid Osprey was shot at Littlehampton, on the coast of Sussex, with a fish 5 lbs. weight in its mouth.

Conclusion.—There are many points in the history and economy of birds which crave our sympathy while they elicit our admiration. Their indubitable courage and miraculous powers of flight invest them with a superior dignity, and secure for their order almost a duality of existence. The Swallow, tiny and inconsiderable as it may appear, can traverse 1000 miles at a single journey; and the Albatros, despising compass and landmark, trusts himself boldly for weeks together to the mercy or fury of the mighty ocean. The huge Condor of the Andes, lifts himself by his sovereign will, to a height where no sound is heard, save the airy tread of his vast pinions, and, from an unseen point, surveys in solitary grandeur the wide range of plain and pasture-land†; while the Bald Eagle, nothing daunted by the din and indescribable confusion of the queen of waterfalls, the stupendous Niagara, sits composedly on his giddy perch, until inclination or desire prompts him to plunge into or soar above the drenching mists which, shapeless and ubiquitous, perpetually rise from the hissing waters of the nether cauldron.

RÉSUMÉ.

In taking a survey of the various topics touched upon in the course of my observations, I find they may be tabulated as follows:—

I. In land-animals, the bodies are heavy, and the feet comparatively small, the surface trod upon giving the requisite degree of support and resistance, and offering little if any impediment in the way of displacement. The feet of the Horse, Deer, and Ox furnish examples.

II. In quadrupeds and birds which take to the water, the feet are expanded, and supplied in many cases with membranes, which assimilate them in some respects to paddles, the flattened surfaces of the feet being alternately applied to the water, in the plane of greatest and least resistance, by a partial rotation of the extremities, this result being likewise obtained by the opening and closing of the feet. In either case the feet act as inclined planes, progression being secured by the alternate increase and diminution of the angle in the plane of progression. The Sea-bear, Turtle, Ornitho-

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bably does, display others running parallel with it, or pursuing a spiral, slightly oblique, oblique, and very oblique, or even a transverse direction.

* The Heron is in the habit, when pursued by the Falcon, of disgorging the contents of his crop in order to reduce his weight.

† The Condor, on some occasions, attains an altitude of six miles.

rhynchus, and the various kinds of swimming birds may be cited. The principle here adverted to is likewise traceable in the movements of *Clio borealis*, the *Rotifera*, and *Medusæ*, the mushroom-shaped disk of the latter opening and closing, and affording perhaps the simplest illustration of the efficacy of the inclined plane that can be given.

III. In fishes, the hands and feet, as is well known, are absent. The body, however, is much elongated, and in some cases greatly flattened, the vertebral column possessing that freedom of motion which enables the animal to apply the hinder half of the trunk to the water very much as a boatman would an oar in sculling. By a series of lashing, flail-like strokes, in which the tail is made to move vigorously from side to side or is briskly twisted and untwisted, the degree of resistance and non-resistance requisite for propulsion in this medium is obtained. While the tail is oscillating from side to side, it is made to rotate slightly on its axis, so as to diminish the amount of surface exposed during flexion or when it is drawn slowly from the mesial line, as happens in the back stroke,—the flat of the tail being applied during extension, or when the tail suddenly springs towards the mesial line, as happens in the effective stroke. The tail of the fish acts as an inclined plane in two directions: but that plane acts the most effectively which is directed towards the axis of the fish, because of the increased velocity with which it is urged, and the greater area presented by it. The amount of surface applied to the water by the fish is greater than in the amphibia and birds, and hence its greater speed. The sea-mammals, as the Whale, Dugong, Manatee, and Porpoise, swim precisely as the fish does, with this difference, that the tail strikes vertically instead of horizontally. The Walrus and Seal are exceptional in this respect.

IV. In the Flyingfish, provision is made for the animal leaving the water for a brief interval. It is consequently furnished, in addition to its swimming-tail, with greatly expanded pectoral fins, which, when the creature takes to the air, can be raised above the body, till they make a certain angle with it. As the fins, while they are being extended, are raised, expanded, and turned in an outward direction till they make an angle of 30°, or thereabouts, with the horizon, and closed, turned inwards, and lowered when they are flexed, they act upon the air from beneath, after the manner of a kite. Here, again, the resistance and non-resistance necessary to sustain the fish in the air is obtained by the fins acting as inclined planes at variable angles, the inclined planes and the weight of the body reacting upon each other, and mutually contributing to this result. In the flight of insects, bats, and birds, *weight* is to be regarded as an independent moving power, this being made to act upon the oblique surfaces presented by the wings in conjunction with the power expended by the animal—the latter being, by this simple combination, conserved to a remarkable extent. Weight, therefore, assisted by the elastic ligament or spring *, which recovers the wing in flexion, is to be regarded as the mechanical expedient resorted to by nature, in supplementing the efforts of all flying things. Without this, flight would be of short duration, laboured, and uncertain, and the almost

* Weight, as every one knows, is the sole moving power in the clock—the pendulum being used merely to regulate the movements produced by the descent of the leads. In watches, the onus of motion is thrown upon a *spiral spring*; and it is worthy of remark that the mechanician has seized upon, and ingeniously utilized, two forces largely employed in the animal kingdom.

miraculous journeys at present performed by the denizens of the air rendered impossible.

V. In the bat, the only mammal at present known to fly, the surfaces employed in locomotion are enormously increased, from the fact of their being destined to operate on the air, at once the lightest and rarest of the media adapted for transit. The bat is, therefore, assimilated in structure to the bird, as the sea-mammals are assimilated to the fish. The bat secures the degree of resistance and non-resistance necessary for propulsion by contracting and raising the wing in its plane of least resistance on the one hand, and by expanding and depressing it in its plane of greatest resistance on the other. The bones of the arm and hand supply the degree of rotation necessary for increasing and diminishing the extent of surface—this being greatest when the wing makes an angle of something like 30° with the horizon, when the effective or down stroke is given. The bat *agrees* with the insect, and *differs* from the bird, in flying by the aid of a continuous membrane; while it *agrees* with the bird, and *differs* from the insect, in alternately extending and folding its pinion *. It has, however, this feature in common, and it is significant—it applies its wing to the air as an inclined plane, the plane travelling from the point of least resistance when the wing is flexed, to that of greatest resistance when it is extended, and when it makes an angle of 30°, or thereabouts, with the horizon. The peculiar power residing in the inclined plane formed by the wing is in part referrable to the weight of the bat, the inertia of the trunk acting in conjunction with the wing upon the air, to produce a recoil, which carries the whole in an upward and forward direction. The same holds true of the insect and bird.

VI. In the insect, the wing is more or less twisted upon itself, as in the helix, or screw, the anterior margin being greatly thicker than the posterior, which yields slightly to prevent shock. The wing, whatever its position during the period of repose, travels from the point of least resistance (usually its plane of rest †) till it makes an angle bordering upon 30° with the horizon, when the effective or down stroke is added, so that it, too, acts as an inclined plane, the angle being increased during extension, when the effective stroke is given, and decreased during flexion, when it travels back to its starting-point. The double hinge, or compound joint, by which the wing is attached to the trunk, secures the rotation or twisting necessary for this purpose.

VII. In the bird the wing is more highly differentiated than in any other animal; it, in fact, presents the distinguishing features of the wings of the insect and of the bat. Thus *it resembles* that of the bat in having a bony skeleton furnished with joints and appropriate muscles, neither of which are found in the insect, and in presenting a compact resisting surface during extension, when the effective or downstroke is made. *It differs*, however, from the bat's wing during flexion, when the back stroke is given, as the surface then

* In the locusts and beetles, there is, I imagine, a certain degree of folding in flexion of the wing, and of unfolding or opening out during extension. In the Albatros, the wing in some respects resembles that of the insect, from its being habitually extended, and because of the great number of the wing-coverts and subcoverts, which do not admit of the wind passing between the feathers. In *Alucita hexadactyla*, the different parts of the wing are used like the separate feathers of the wing of the bird. These afford examples of modification, the principle involved always remaining the same.

† The Dragonflies are exceptional, their position of rest being that of greatest resistance.

presented is, with few exceptions, broken up to diminish the resistance, by permitting the air to escape. This peculiarity in the wing of the bird is occasioned by each primary, secondary, and tertiary feather rotating upon its axis to procure the maximum of resistance during extension, and the minimum of displacement during flexion, as happens in the wing of the insect. The wing of the bird is consequently an advance upon those of the insect and bat, since it combines the advantages peculiar to each. The wing of the bird, in virtue of its shape and conformation, acts as a twisted inclined plane, in other words, as a helix or screw—the mere extension of the wing, because of the spiral arrangement of the joints, causing it to rotate from its plane of least resistance till it makes an angle approximating to 30° with the horizon, the reverse of this occurring during flexion. In this respect it intimately agrees with the wing of both the insect and bat, thus proving that, however the instrument of flight may be modified, the principle involved is the same in all.

VIII. All wings act as levers of the third order, a very slight movement at the root of the pinion being followed by an immense sweep of its tip or extremity. This large sweep is necessary for compressing the vast quantity of air which is to supply the fulcrum for elevating, propelling, and sustaining.

IX. All wings are twisted upon themselves naturally. They, moveover, twist upon themselves during their action; so that the course described by them, or, what is the same thing, the blur or impression produced on the eye by their action is essentially spiral in its nature. It, in fact, closely resembles in its appearance the blade of a screw propeller—the velocity with which the wing is driven causing the blur to assume a more or less solid aspect.

X. The wing exceeds, in elevating-, propelling-, and sustaining-power, every form of screw yet devised, the rare combination of rigidity, elasticity, and mobility which it displays enabling it to strike the air at various degrees of obliquity during the down and up strokes, and this in a manner which insures a maximum result with a minimum expenditure of power. The effect is such as could not be produced by wholly rigid materials, however fashioned and applied.

XI. The wings, during the down and up strokes, describe a wave-track, the termination of the up and the beginning of the down stroke corresponding to the crest of the wave, the down stroke to the slope or side of the wave which is inclined forwards, or in the direction in which the wave is supposed to travel, the termination of the down and the beginning of the up stroke coinciding with the hollow of the wave, and the up or return stroke with that slope or side of the wave which is inclined backwards, *i. e.* in a contrary direction to the plane of progression. The down and up strokes may consequently be conveniently divided into four stages, the first two consisting of preparation for the down stroke and the down stroke itself, the remaining two to preparation for the up stroke and the up or return stroke. The body may thus be said to glide along by a series of gentle undulations or gradients.

XII. The wings, while they are describing the wave-tracks referred to during the down and up strokes, are in addition rotating upon their long axes, to increase the angle which they make with the horizon during their descent, and to diminish it during their

ascent, the angle being greatest at the middle of the down stroke, and least at the middle of the up or return stroke. The increase and diminution of the angle is necessary for two reasons:—1st, to increase the elevating-, propelling-, and sustaining-power; and 2ndly, to diminish the amount of slip or waftage.

XIII. In those birds which fly under the water, the wings do not act as in ordinary flight. In them the back of the pinion gives the effective stroke, and this is delivered downwards and backwards instead of downwards and forwards. This is necessary, in order that the wings may make the same angle, and strike in the same direction as the feet, with which they may or may not act in conjunction, the stroke being reversed on account of the greater buoyant power of the water and the increased resistance opposed to the foot by this element. In the Penguins and Auks, which cannot fly out of the water, the wings are, for this purpose, completely twisted round—in fact, reversed. In these curious birds, progression is effected by the employment of the wings and feet also, after the manner of inclined planes, these acting at variable angles and at different degrees of obliquity. The inclined plane, therefore, however disguised and employed, forms an essential feature in animal progression, whether on the land, in the water, or in the air.

In the solidungulate animals, as the Horse, Ass, and Zebra, it appears as the small horny hoof; in the amphibia, as the actively contracting and expanding foot; in the fish, as the tail and lower portion of the body; and in the bat, insect, and bird, as the greatly expanded pinion. The size of the plane is diminished on the land, increased in the water, and excessively so in the air. In either case it is the agent of a powerful muscular system, and is applied in such a manner as at once to support and lever the animal forwards. I say "support," because, as I have shown, the wing, which is simply a lever, can sustain the bat, insect, and bird even in the thin medium of the air.

EXPLANATION OF THE PLATES.

Plate XII. is intended to show the comparatively small extremities and travelling surfaces employed by land-animals, their gradual increase in such as take to the water occasionally and in such as live in it permanently, and their still greater increase in such as betake themselves for short intervals to the air.

Plate XIII. shows the extensive surfaces required for taking long leaps and for flight, and the relative proportions of the pinions in bats and insects.

Plate XIV. displays the relative proportion and size of the wing in light and heavy-bodied birds, and in quick- and slow-flying ones.

In Plate XV. the extremities and travelling surfaces of animals are compared, and the manner of their application to the land, water, and air indicated.

The relative proportions of the extremities to the animals are in all cases strictly observed, and the shape and extent of wing accurately given.

The figures, 78 in number, are, with the exception of 6, original.

PLATE XII.

Fig. 1. Chillingham Bull (*Bos Scoticus*). From Dallas. Shows powerful heavy body, and the small extremities adapted for land transit.

Fig. 2. The Common Otter (*Lutra vulgaris*), adapted for land and water.

Fig. 3. The Ornithorhynchus (*Ornithorhynchus paradoxus*, Blum.), adapted likewise for land and water, the extremities being more expanded than in the Otter.

Fig. 4. The Seal (*Phoca fœtida*, Müll.), adapted principally for water, the extremities being larger than in either of the foregoing.

Fig. 5. The little Penguin (*Aptenodytes minor*, Linn.), adapted almost exclusively for swimming and diving.

Fig. 6. The Sea-Bear (*Otaria Hookeri*), adapted principally for swimming and diving. It also walks with tolerable facility. Its extremities are larger than those of the Seal, and its movements, both in and out of the water, more varied.

Fig. 7. The Turtle (*Chelonia imbricata*), adapted for swimming and diving, the extremities being relatively larger than in any of the preceding.

Fig. 8. The Crested Newt (*Triton cristatus*, Laur.). In this a tail is superadded to the extremities, the tail and the extremities both acting in swimming.

Fig. 9. The Manatee (*Manatus americanus*). Here the tail is principally employed in swimming, the anterior extremities being rudimentary and small.

Fig. 10. The Porpoise (*Phocœna communis*). The anterior extremities of the Porpoise are more rudimentary and finlike than those of the Manatee, the tail and under part of the body being finely moulded, and chiefly engaged in locomotion. The Manatee and Dolphin strike the water from above downwards or vertically; and in this respect they differ from the newt and fish, which strike it laterally or from side to side.

Fig. 11. The Salmon (*Salmo salar*). In this the extremities have disappeared, the travelling-power residing in the lower half of the body and greatly expanded tail. If the lower part of the body and tail be compared with the feet of the ox (fig. 1), the increase of surface engaged in locomotion becomes very evident.

Fig. 12. The Flyingfish (*Exocœtus exsiliens*, Linn.). Here the creature is adapted both for swimming and flying. The swimming-tail is consequently retained, and the pectoral fins, which act as wings, are enormously increased in size. The pectoral fins are not sufficiently large to support the fish permanently in the air. They, however, do this very efficiently for short periods. The Flyingfish may be regarded as forming one of the connecting links between the water and the air, the heavy-bodied short-winged swimming and diving birds forming the other. The wing of the Flyingfish is elevated and rotated in an outward direction at one and the same time; so that it strikes the air from beneath, as a boy's kite would.

Plate XIII.

Fig. 13. The Red-throated Dragon (*Draco hæmatopogon*, Gray) shows a large membranous expansion (*a b*) situated between the anterior and posterior extremities and supported by the ribs. The Dragon by this arrangement can take extensive leaps with perfect safety.

Fig. 14. *Alucita hexadactyla* (from Dallas). In this curious insect the wing is composed of separate filaments or winglets, which in flight act like cilia. They present a broken surface in action, like the feathers of the wing in flexion, which in some respects they resemble. They differ in this respect from the wings of the bat and those of insects generally. When the insect is reposing they fold up like a fan.

Fig. 15. The bat (*Phyllocina gracilis*, Peters). Here the travelling-surface (*r d e f, n n n*) is enormously increased as compared with that of the land- and water-animals generally. It, moreover, greatly exceeds that found in many of the insects (fig. 16) and birds (Plate XIV. fig. 32).

Fig. 16. The Centaur Beetle (*Augusoma centaurus*), seen from above. Shows two pairs of elytra (*r*), and two pairs of membranous wings (*e*) in the extended state. The nervures are arranged and

jointed in such a manner that the membranous wings can be folded (*e*) transversely across the back during repose. In such a position the anterior or thick margins of the wings are directed outwards and slightly downwards, the posterior or thin margins inwards and slightly upwards. During extension the positions of the margins are reversed by the wings twisting and rotating upon their axes, the anterior margins, as in bats and birds, being directed upwards, and making a very decided angle with the horizon. The wings in the beetles are insignificantly small when compared with the area of the body. They are, moreover, finely twisted upon themselves, and possess great power as propellers and elevators.

Fig. 17. Under surface of large beetle (*Goliathus micans*), showing that the wings are deeply concave, and that the nervures (*d, e, f, n, n, n*) are arranged, along the anterior margins of the wings and throughout their substance generally, very much as the bones of the arm (fig. 15 *r*), forearm (*d*), and hand (*f*) are in the wings of bats, to which they bear a very marked resemblance both in their shape and mode of action. The wing is folded upon itself at the point *e* during repose.

Fig. 18. The Flying Colugo (*Galeopithecus volans*, Shaw). In the Flying Lemur the membranous expansion (*a b*) is more extensive than in the Flying Dragon (fig. 13), and is supported by the neck, back, and tail, and by the anterior and posterior extremities. The Flying Colugo takes enormous leaps; and the amount of surface which it displays all but enables it to fly. This effect is secured in the bat, *Phyllorhina gracilis* (fig. 15), with a very slight increase of surface, the membranous expansion in this case being supported by the neck, back, tail, and extremities, the greatly elongated phalanges taking a principal part. The surface exposed by the bat exceeds, as has been explained, that displayed by many insects (compare with figures 16, 17, and 19) and birds (compare with figures 31, 32, and 34, Plate XIV.). The wings of the bat are deeply concave, and so resemble the wings of beetles (fig. 17) and heavy-bodied short-winged birds (fig. 32, Plate XIV.). The bones of the arm (*r*), forearm (*d*), and hand (*n, n, n*) of the bat (fig. 15) support the anterior or thick margin and the extremity of the wing, and may not inaptly be compared to the nervures in corresponding positions in the wing of the beetle (fig. 17 *d, e, f, n, n, n*).

Fig. 19. Sphinx Moth, having large body and comparatively small wings. The wings are exquisitely curved and twisted upon themselves, and act as helices or screws during flight. They possess great elevating- and driving-power. If this moth be compared with the Butterfly (fig. 27), it will at once be perceived that no fixed relation can exist as to the weight of the body and the expanse of the wing.

Fig. 20. The Bluebottle or Blow-Fly (*Musca vomitoria*), characterized by its comparatively small, finely moulded, twisted wings. The Bluebottle flies with great rapidity, precision, and power. The wings are not unlike those of the moth (fig. 19).

Fig. 21. The Cockroach (*Tetraclyta porosa*). In this insect the elytra or wing-covers (*r*) are semimembranous; they are geared to the membranous or under wings (*a*) by a hook, the two acting together in flight. When so geared, the upper and under wings are delicately curved and twisted, and finely graduated from within outwards and from before backwards. That the two act spirally, after the manner of a screw, is proved by the fact that, when the insect is reposing, the anterior or thick margins of the upper and under wings are directed *downwards*, whereas, when the wings are extended, as shown in the figure, they are directed *upwards*, and make a certain angle with the horizon. This change is occasioned by the wings during extension describing a spiral course which causes them completely to alter their position. The same happens in the bat and bird, the conformation of the joints in the latter necessitating the spiral movement in question.

Fig. 22. The Cicada, as seen from above during repose, the wings slating the back of the insect. In this case the anterior or thick margins of the wings (*e f*) are directed decidedly downwards, the

posterior or thin margins decidedly upwards. This is better seen in fig. 25. When the wings are extended, the positions of the margins are reversed, the anterior thick margins rotating or twisting in an upward direction, the posterior thin ones in a downward direction. Here, again, the wings are jointed in such a manner as to ensure their describing a spiral course.

Fig. 23. The Locust (*Gryllus migratorius*). In the Locust the upper (*r*) and under (*f*) wings are semimembranous and independent of each other. The under wings (*a*, *b*) during repose are crushed up after the manner of a fan. In flight they are expanded and rotated or twisted as in the Beetle, Cockroach, and Cicada. The upper wings follow the same principle, and act mechanically as gliders.

Fig. 24. The Dragonfly (*Petalura gigantea*). In this insect the wings are finely curved and delicately transparent, the nervures being most strongly developed at the roots of the wings and along the anterior margins. The anterior pair (*e*) are analogous in every respect to the posterior (*f*). Both make a certain angle with the horizon, the anterior pair (*e*), which are principally used as elevators, making a smaller angle than the posterior pair (*f*), which are used as drivers. The wings of the Dragonfly make the proper angle for flight even in repose, so that the insect can take to wing instantly. It flies with astonishing velocity.

Fig. 25. Lateral view of Cicada, showing that the thick margin (*e f*) of the wing is directed downwards, the thin one (*a b*) upwards. The wings may consequently be said to slate the insect, as the roof slates a house.

Fig. 26. The Butterfly (*Morpha Hélénor*, Vampa), from Milne-Edwards. In the Butterfly the wings (*e d*, *a a'*) are raised vertically above the body in repose, so that, before flight can be effected, they require to be lowered and slewed round until they make an angle of something like 30° with the horizon. The wings of the Butterfly rotate on their axes during flight, as in the other insects described.

Fig. 27. A Butterfly with comparatively very large wings (*a a'*). The nervures are seen to great advantage in this specimen; and the enormous expanse of the pinions readily explains the irregular flight of the insect, on the principle of recoil.

Plate XIV.

Fig. 28. The Lammer-Geyer (*Gypaëtos*) (from Milne-Edwards), shows powerful deeply concave wings (*d e f*, *c b*) elevated preparatory to flight.

Fig. 29. The Lapwing, or Green Plover (*Vanellus cristatus*, Meyer), with one wing fully extended (*c b*, *d' e' f'*), the other being in a semiflexed condition (*d e f*, *c b*). In the extended wing the anterior or thick margin (*d' e' f'*) of the pinion is directed *upwards and backwards* (*vide* arrow), the posterior or thin margin (*c b*) downwards and forwards. The reverse of this happens during flexion, the anterior or thick margin (*d e f*) of the pinion being directed *downwards and forwards* (*vide* arrow), the posterior or thin margin bearing the rowing-feathers upwards and backwards. The wings therefore twist in opposite directions during extension and flexion; and this is a point of the utmost importance in the action of the wings, as it enables the bird to rotate the primary, secondary, and tertiary feathers on and off the wind, and to present at one time (in extension) a resisting, angled, kite-like surface, and at another (in flexion) a knife-like and comparatively non-resisting one.

Fig. 30. The Cape Barn-Owl (*Strix capensis*, Smith), as seen in full flight, hunting. In this case the wings are ample as compared with the body. Like all other wings in the extended state, their anterior or thick margins (*d e f*) are directed upwards, their posterior or thin margins (*c b*) downwards. The wings consequently make an angle of something like 30° with the horizon. The angle is diminished during flexion, and can be altered at the will of the bird. It is occasioned by the rotation of the bones of the wing on their axes during extension.

Fig. 31. The Red-legged Partridge (*Perdix rubra*) with wings fully extended as in rapid flight, shows deeply concave form of the wings, how the primary and secondary feathers overlap and support each other during extension, and how the anterior or thick margins of the wings are directed upwards and backwards, the posterior or thin ones downwards and forwards. The wing in the Partridge is wielded with immense velocity and power; and this is necessary because of its small size when compared with the great dimensions and weight of the body.

Fig. 32. The same, seen from the side. If a horizontal line be drawn across the feet (*a e*) to represent the horizon, and another from the tip of the tail (*a*) to the root of the wing (*d*), the angle at which the wing strikes the air is given. The wing in the Partridge is rounded and broad.

Fig. 33. The Pigeon (*Treron bicincta*, Jerdon), as seen in the act of alighting. In this case the wings are more or less pointed and powerful as compared with the dimensions of the bird. The Pigeon expands its tail both in ascending and descending. The overlapping of the feathers of the wings and tail can readily be seen in this figure.

Fig. 34. The Red-headed Pochard (*Fuligula ferina*, Linn.) in the act of dropping upon the water, the head being inclined forwards, the feet expanded, and the wings partially flexed. The feathers of the wing are consequently slightly thrown out of position, the wind being permitted to pass between them. This is occasioned by the primary, secondary, and tertiary feathers not overlapping each other to any great extent.

Fig. 35. The Curlew (*Numenius arcuatus*) in the act of rising. Here the body and wings are both inclined at a decided angle upwards, the whole bird presenting a kite-like surface. The wings are long, narrow, and pointed; and the bird is a powerful flier.

Fig. 36. The Common Snipe (*Scolopax gallinago*) in the act of alighting. In this case the direction of the inclined plane is reversed, the bird darting downwards like a boy's kite when stooping. The wings of the Snipe are pointed, finely twisted upon themselves, and very powerful. Their anterior or thick margins are in the present instance directed downwards, their posterior or thin margins, with the tail, which is fully expanded, being directed upwards.

Fig. 37. The Common Duck (*Anas domestica*) ascending and in the act of turning. The wings in the Duck are more or less pointed, and beautifully formed. The bird is capable of enormous flights.

Fig. 38. The Grey Heron (*Ardea cinerea*) immediately after rising. In the Heron the wings are deeply concave, and unusually large as compared with the size of the bird. The result is, that they are moved very leisurely; and every one is acquainted with the slow, heavy, and almost solemn flight of the bird. The Heron figured weighed under 3 lbs.; and the expanse of wing is considerably greater than in the Wild Goose represented at fig. 42, which weighed over 9 lbs. Flight is consequently more a question of power and weight than of buoyancy and surface.

Fig. 39. The Common Snipe (*Scolopax gallinago*) descending parachute-fashion, the weight of the body dragging upon the wings, which, again, are operating on the air.

Fig. 40. The Pigeon (*Treron bicincta*) descending headlong, and using the wings partly as parachutes.

Fig. 41. The Rook (*Corvus frugilegus*) as seen shortly after rising, and before it has got fairly on the wing. In such cases the extent of the downward and upward strokes is very great, the tips of the wings being made nearly to touch each other both above and beneath the body. The wing of the Rook is powerful, but by no means finely formed.

Fig. 42. The Wild Goose (*Anser ferus*, Linn.) as seen in full flight and ascending slightly. The wings in this instance are beautifully moulded and very compact and powerful. They are distinctly twisted upon themselves, and act with unusual efficacy as elevators and propellers. The angle of flight can be readily obtained by drawing a horizontal line across the feet to indicate the horizon, and another through the left foot of the bird, along the root of the left wing, and through the neck and head.

Fig. 43. The Rook (*Corvus frugilegus*), with wings elevated and in the act of springing from the earth. The Rook and most other birds secure, by a vigorous leap, the altitude requisite for the effective play of their pinions. This figure shows how the feathers of the wing overlap each other.

Plate XV.

Fig. 44. Extreme form of compressed foot, as seen in the Deer (*r*) Antelope, Ox, &c., adapted specially for land transit.

Fig. 45. Extreme form of expanded foot, as seen in the *Ornithorhynchus* (*r*), &c., adapted more particularly for swimming.

Figs. 46 & 47. Intermediate form of foot, as seen in the Otter (fig. 46), Frog (fig. 47), &c. Here the foot is equally serviceable in and out of the water.

Fig. 48. Foot of the Seal (*z*), which opens and closes in the act of natation, the organ being folded upon itself during the non-effective or return stroke, and expanded during the effective or forward stroke. Due advantage is taken of this arrangement by the Seal when swimming, the animal rotating on its long axis, so as to present the lower portion of the body and the foot obliquely to the water during the return stroke, and the flat, or the greatest available surface of both, during the effective or forward stroke.

Fig. 49. Fish in the act of swimming, the body being slightly rotated, tilted or twisted, as happens at the beginning of the effective or forward stroke. In this case the tail is slightly compresed, the lower portion of the body presenting a concave or biting surface towards the long axis of the fish. When the mesial line (*a*) is passed, the *concave* surface presented by the tail and lower portion of the body becomes a *convex* one, and the non-effective or return stroke is commenced. The fish advances by powerful lateral strokes of the tail, the body being rotated on its long axis to diminish the surface presented by the tail and the lower portion of the trunk during the return stroke, and to increase it during the forward one. The surface exposed during the effective or forward stroke is in some instances augmented by the rays of the caudal fin divaricating or expanding.

Fig. 50. The Manatee swimming. In this instance the tail is fleshy, and consequently incapable of increase or diminution as regards its actual breadth. The swimming of the Manatee differs from that of the fish as regards the direction of the stroke, the Manatee lashing the water with the tail and the lower portion of the body vertically, or from above downwards, the tail of the fish in all instances oscillating from side to side, or laterally. The Manatee, like the Fish, rotates on its long axis (*a*) during the non-effective or return stroke, and likewise during the effective or forward stroke, the partial rotation, tilting, or twisting of the body enabling it to present the minimum and maximum of surface alternately.

Fig. 51. The Otaria or Sea-Bear, swimming.—In the Sea-Bear the principal organ of natation is the anterior extremity or flipper, the partial rotation, twisting, and curving of the body and posterior extremities (*x*) assisting rather in directing the movements and regulating the course of the animal. To make up for the comparative inactivity of the body, the twisting, spiral, or rotatory movements of the spine are, curiously enough, transferred to the anterior extremity, or flipper (*c d*), whichacts as a true helix or screw. Compare the flipper (*c d*) with *c d* of fig. 52, which represents the blade of a screw-propeller. During the return stroke, or when the flipper is carried away from the body in the direction of the line *a b*, the flipper presents a convex surface (*c*) and rolls from below upwards until it attains the position *a b*, when it presents a cutting edge to the water. During the effective or forward stroke a reverse movement takes place (see arrow), the flipper gradually presenting a *concave* or biting surface (*d*).

Fig. 52. Blade of an ordinary screw-propeller: *c a*, convex surface of blade; *d a*, concave or biting surface of blade. Compare convex (*c a*) and concave (*d a*) surfaces of this figure with correspond-

ing surfaces *c* and *d* of figs. 51, 55, and 57; with *a a'* of fig. 58; with *c a b* and *f e d* of figs. 60 and 62; with *f a* and *a' f'* of fig. 61; with *d f* and *c b* of figs. 68, 69 & 70, and with *f b* and *d e* of figs. 73 & 74. A careful comparison of the surfaces (*c a, d a'*) presented by this fig. (52) with the corresponding surfaces of figs. 51, 55, 57, 60, 62, 68, 69, 70, 73, 74 & 75, will show that the anterior extremities of the Sea-Bear, Turtle, and Auk, and the wings of insects, bats, and birds are twisted upon themselves, and form true screws; and a comparison of the surfaces in question with the blur or impression produced on the eye by the rapidly oscillating wing of the insect (figs. 58 & 59) and bird (fig. 61) will show what is still more remarkable, viz. that the wing in action rotates on its long axis, and describes a spiral or wave-track, in fact a sort of shadow or spectre screw. This is particularly evident when *a a'* of fig. 52 is contrasted with *a a'* of figs. 58, 59, and 61. From this it is clear that the tails of fishes, Whales, Manatees, and Dugongs, the posterior extremities of Seals and Walruses, the anterior extremities of Sea-Bears, Turtles, and swimming birds (Auks), and the wings of beetles, bats, and birds are either screws originally, or become such when in motion, *i.e.* when performing the various functions delegated to them in swimming and flying. They are consequently formed according to a common type; and the physiology of the one is, with trifling modifications, the physiology of all.

Fig. 53. Swallow, in the act of flying. This bird is remarkable for the great length of the primary feathers (*f*) of the wing, which gives it a pointed, scythe-like appearance. The Swallow and all birds apply their wings to the air by a twisting rotatory movement of the wing on its long axis, the angle which the wing makes with the horizon in a direction from above downwards and from behind forwards being increased during the effective or down stroke, a reverse movement taking place during the return or up stroke.

Fig. 54. Swan, in the act of swimming, the right foot fully expanded, and about to give the effective stroke, which is delivered outwards, downwards, and backwards, as represented at *r* of fig. 77, the left foot being closed, and about to make the return stroke, which is delivered in a forward, upward, and inward direction, as shown at *s* of fig. 77. The feet are slightly rotated on their long axes, or tilted, both during the effective and non-effective strokes; and as they always move in curves, their course is accurately represented by a double spiral, as shown at fig. 77. Compare the spirals formed by the feet of the bird in swimming with those described by the fish (fig. 76), and by ourselves in walking (fig. 78).

Fig. 55. Turtle, swimming. Here both the anterior (*c*) and posterior (*x*) extremities are engaged in natation. The effective stroke is delivered when the feet are being flexed or pushed in a backward direction (*vide* arrows). What was said of the movements of the anterior extremities of the Sea-Bear (see under fig. 51) applies also to the extremities of the Turtle.

Fig. 56. Glow-worm, in flight. Here the elytra, or horny anterior pair of wings, are elevated and carried forward beyond the reach of the posterior or membranous wings, which are the true organs of flight; the elytra, which form curved inclined planes, acting as sustainers rather than elevators and propellers. The posterior or true wings rotate on their long axes during their ascent and descent, as in the bird (see under fig. 53).

Fig. 57. Penguin, swimming. What was said of the anterior extremity of the Otaria or Sea-Bear (fig. 51) applies equally to the rudimentary or swimming-wing of this remarkable bird. For the movements of its feet, see under fig. 54. I need only add that the wings move synchronously or together, the feet alternately.

Fig. 58. Blur or impression produced on the eye by the rapid oscillation of the wing of the Blow-Fly, when the insect is fixed. Seen from above. This figure represents the rotating of the wing on its long axis, and the double cone which it forms during its ascent and descent. Of the cones referred to, that marked *a* presents a *convex* surface, and is caused by the pinion rotating on its long axis in a direction from above downwards, and from behind forwards, as in the be-

ginning of the down stroke (compare with *a*, of Diagram 6, p. 233); the other (*a'*) presents a concave surface, occasioned by the rotating of the wing in an opposite direction, as seen towards the termination of the down stroke (compare with *d*, of Diagram 6, p. 233). The wing, therefore, during its descent, describes a twisting, sinuous, or wave-like track, which is differently, but equally faithfully, represented at *a a'* of fig. 59. The track described by the wing, or, what is the same, the blur or impression produced on the eye by its continuous and rapid action, is, in fact, spiral in its nature; and if the space traversed by the wing were represented by a solid, it would take the form of the blade of a screw-propeller, as shown at *ca, da*, of fig. 52.

Fig. 59. Blur or impression produced on the eye by the rapidly oscillating wing of the Blow-Fly when the insect is progressing at a high speed. Seen from above and from the side. In this case the sinuous path or wave-like track (*a a'*) described by the wing during its descent and ascent is more apparent than in fig. 58, which is intended more especially to show the rotatory action of the pinion. The present figure represents the wing towards the termination of the down stroke (*a*) and the beginning of the up one (*a'*), the wing during its continuous action ascending and falling in a series of curves, the down movement gliding into the up one without hitch or impediment, as represented at diagram 6, p. 233. Here also the track described by the extremity of the wing (fig. 59 *a a'*) corresponds to the curve described by the extremity of the ordinary screw propeller, as a comparison of *a a'* of the present figure with the corresponding letters of fig. 52 will readily show. While, therefore, the extremity of the wing and the wing itself is describing a series of graceful curves whose convexities are directed alternately upwards and downwards, which has the effect of equalizing the motion, the body of the insect is carried steadily along a given line, its position being always midway between that assumed by the wing at the beginning or termination of the up and down stroke. The horizontal track described by the trunk is owing to the great regularity with which the wing is driven, the extreme speed converting what would otherwise be an unequal jerking motion into a gliding one remarkable for its smoothness.

Note. Figs. 58 and 59 show the comparatively large *supporting* and *balancing* area (*a a'*) furnished by the wings when in motion.

Fig. 60. Kestrel or Windhover, hunting (after a spirited engraving by Mr. Wolff in His Grace the Duke of Argyll's work, 'The Reign of Law'). Here the bird is represented as balancing or poising itself in the air. This feat is accomplished by the wings making a series of short strokes, the wing in no instance descending quite to the level of the body. The angle made by the wing with the horizon is also greatly increased, the wing on some occasions reversing slightly. The body, which is suspended from the wings as from a parachute, is, moreover, inclined almost perpendicularly, the tail, which is spread out, being directed downwards and forwards, and assisting the wings in maintaining the equilibrium of the trunk. In some instances the balance is so accurately maintained that the bird seems actually fixed in the air; and those who have been privileged to behold the Kestrel in this position will not soon forget the pleasure afforded by the sight. The Humming-bird and Humming-bird Moth (*Macroglona stellatarum*) are likewise capable of performing this dexterous feat in wing aeronautics. *d e f*, anterior or thick margin of the wing; *b a c*, posterior or thin margin, formed by the primary (*b*), secondary (*a*), and tertiary (*c*) feathers. At *c'* the wind escapes after having been forced in a spiral groove along the under surface of the wing. The groove in question is well seen at *f g* of fig. 62 (*vide* arrows). *t*, tail spread out so as to assist in maintaining the elevated position of the head and anterior portion of the bird.

Fig. 61. Blur or impression produced on the eye by the rapid oscillation of the left wing of the bird. Seen from the left side. Shows how the wing rotates or twists on its long axis, and describes a spiral track, *a a'*, during its descent and ascent. It also shows that the down, or effective stoke,

is delivered obliquely downwards and forwards, and not vertically or slightly backwards, as is generally stated. During the return or up stroke the movement is reversed. *x*, long axis of the body, which may be regarded as running through the root of the wing, the body being inclined upwards as in flight; *d*, root of wing; *d f*, anterior or thick margin when the wing is elevated preparatory to the down stroke; *d f'*, anterior or thick margin when the wing is depressed, as happens at the termination of the down stroke; *a a'*, spiral track described by the posterior or thin margin of the wing during its descent and ascent. Compare with wave-track described by the insect's wing, fig. 59 *a a'*, Diagram 6 *a, b*, p. 233, and with the terminal or free margin of the screw propeller, fig. 52 *a a'*. A careful examination of this figure (61) will show that the anterior or thick margin and the posterior or thin margin of the wing describe different curves, these curves, when the wing is in motion, crossing each other. It also shows that the pinion, whatever its position, presents a concave or biting surface (*a f'*) to the horizon, the convexity of the wing (*f*) being invariably directed backwards. Lastly, it shows that the blur presented by the wing in motion is twisted upon itself precisely in the same manner as the blade of the screw propeller (fig. 52) is twisted upon itself. Compare convex surface *f* (of fig. 61) with convex surface *c* of fig. 52; then the concave surface *f'* of fig. 61 with the concave surface *d* of fig. 52. Compare likewise the free spiral margin *a a'* of fig. 61 with corresponding margin of the blade of the screw-propeller (fig. 52 *a a'*).

Fig. 62. Left wing of the Wild Goose, elevated preparatory to making the effective or down stroke. *d e*, anterior or thick margin of the pinion; *b a c*, posterior or thin margin, formed by the tips of the primary (*b*), secondary (*a*), and tertiary (*c*) feathers; *f g*, spiral concave surface (*vide* arrows) found on the under surface of the wing, along which the wind is forced during the effective or down stroke. The wind escapes under the tertiary feathers (*c*). See also *c* of fig. 75. From this figure (62), and from fig. 75, it will be evident that the wing, when fully extended and ready to give the down stroke, presents a double curve—a large one, whose concavity is directed forwards when the wing is raised (fig. 62 *b a*), and downwards, when the wing is on the same level as the body (fig. 75 *b a*). This curve is formed by the forward inclination of the primary and secondary feathers. The smaller curve is principally formed by the tertiary feathers, which are slightly inclined backwards. It has its convexity directed forwards when the wing is raised (fig. 62 *g*), and downwards when the wing is on a level with the body (fig. 75 *c*). The tip and body of the wing, as will readily be understood, seize the air with avidity, while the root of the wing facilitates its escape when it can no longer be serviceable for elevation and propulson. The wing may therefore be said to be seizing the wind at one part and letting it go at another at one and the same time; and there can be no doubt that the wing in a great measure owes its peculiar efficacy as an elevator and propeller to this circumstance. The grasping and disentangling power possessed by the wing is augmented by the pinion being more or less flexed during the return or up stroke, the flexing or bending of the wing giving rise to a lateral pulsation occasioned by the fact that the curves formed by the posterior or thin margin of the wing during flexion (fig. 73 *b a c*) are reversed during extension (fig. 75 *b a c*).

Fig. 63. Right wing of the Kestrel, drawn from the specimen, while being held against the light. Shows how the primary (*b*), secondary (*a*), and tertiary (*c*) feathers overlap and buttress or support each other in every direction. Each set of feathers has further its coverts and subcoverts, the wing being conical from within outwards and from before backwards. *d e f*, anterior or thick margin of wing; *b a c*, posterior or thin margin. The wing of the Kestrel is intermediate as regards form, it being neither rounded as in the Partridge (fig. 67), nor ribbon-shaped as in the Albatros (fig. 64), nor pointed as in the Swallow (fig. 53). The feathers of the Kestrel's wing are unusually symmetrical and strong.

Fig. 64. Left wing of the Albatros: *d e f*, anterior or thick margin of pinion; *b a c*, posterior or thin margin, composed of the primary (*b*), secondary (*a*), and tertiary (*c*) feathers. In this wing the first primary is the longest, the primary coverts and subcoverts being unusually long and strong. The secondary coverts and subcoverts occupy the body of the wing (*e d*), and are so numerous that they effectually prevent any escape of wind between them during the return or up stroke. This wing, which I have in my possession, measures over 6 feet in length.

Fig. 65. Right wing of Beetle, dorsal surface. This wing somewhat resembles the Kestrel's (fig. 63) in shape. It has an anterior thick margin, *d e f*, and a posterior or thin one, *b a c*. Strong nervures run along the anterior margin (*d*) until they reach the joint (*e*), where the wing folds upon itself in repose. Here they split up and divaricate and gradually become smaller and smaller until they reach the extremity of the wing and the posterior or thin margin (*b*); other nervures radiate in graceful curves from the root of the wing. These also become finer as they reach the posterior or thin margin (*c a*). *r*, root of the wing with its complex compound joint: the wing of the beetle bears a certain analogy to that of the bat, the nervures running along the anterior margin (*d*) of the wing resembling the humerus (fig. 66 *d*) and forearm of the bat, the joint *e* of the beetle's wing (fig. 65 *e*) corresponding to the carpal or wrist-joint (*e*, fig. 66) of the bat, the terminal or distal nervure of the beetle (fig. 65 *f b*) to the phalanges of the bat (fig. 66 *f b*). The parts marked *f b* (figs. 65 & 66) may in both instances be likened to the primary feathers of the bird, that marked *a* to the secondary ones. In the wings of the beetle and bat no air can possibly escape through them during the return or up stroke.

. 66. Right wing of the bat, dorsal surface: *d e f*, anterior or thick margin of the wing, supported by the bones of the arm, forearm, and hand (first and second phalanges); *a b*, posterior or thin margin, supported by the remaining phalanges, by the side of the body, and by the foot.

Fig. 67. Right wing of the Red-legged Partridge, dorsal aspect. Shows extreme example of short rounded wing; contrast with the wing of the Albatros (fig. 64), which furnishes an extreme example of the long ribbon-shaped wing: *b a c*, primary (*b*), secondary (*a*), and tertiary (*c*), feathers with their respective coverts and subcoverts, the whole overlapping and mutually supporting each other. This wing, like the Kestrel's (fig. 63), was drawn from a specimen held against the light, the object being to display the mutual relation of the feathers to each other, and how the feathers overlap.

Fig. 68. Right wing of the Beetle (*Goliathus micans*), as seen from behind and from beneath. When so viewed, the anterior or thick margin (*d f*) and the posterior or thin margin (*b c*) cross each other and form a true helix or screw.

Fig. 69. Right wing of the Bat as seen from behind and from beneath. When so regarded, the anterior or thick margin (*d f*) of the wing displays different curves from those met with on the posterior (*b c*) or thin margin, the anterior and posterior margins crossing each other, as in the blades of a screw propeller.

Fig. 70. Right wing of Red-legged Partridge, seen from behind and from beneath, as in the beetle (fig. 68) and bat (fig. 69). The same lettering and explanation does for all three.

Fig. 71. Small Butterfly, designed to show the kite-like action of the wings in insects, bats, and birds, seen from above and from behind. The wings are depressed in the direction of the arrows *s, r*, towards the body, the straight lines representing the strings of the kites. The tendency of the kites is to rush up in the direction of the arrows *a, b*; but as they are inclined obliquely from behind forwards, they meet and oppose each other in the long axis of the body, and force the body in a nearly straight line (*x*) *from below upwards*.

Fig. 72. Common House-Fly (*Musca domestica*), also intended to show the kite-like action of the wing, seen from above and from the side. In this case the wing is represented as striking from *behind forwards* and from above downwards. The string of the kite is represented by the

straight line marked *s*. The tendency of the kite is to force the body upwards and forwards. The upward tendency, however, is checked by the weight of the insect; and its course is indicated by the arrow marked *n*.

Fig. 73. Left wing of Heron, partially extended, seen from beneath and from behind,—shows the spiral configuration and crossing of the anterior (*def*) and posterior (*c a b*) margins of pinion: *e*, anterior axillary curve pointing downwards; *f*, posterior axillary curve pointing upwards; *c a*, posterior axillary curve pointing upwards; *b*, posterior distal curve pointing downwards. The posterior axillary and distal curve are reversed in complete extension (compare *b a c* of the present fig. with *b a c* of fig. 75).

Fig. 74. Left wing of Snipe, rather more than half extended, seen from behind. In this figure the posterior axillary (*c*) and distal (*b*) curves are seen in the act of reversing, the posterior or thin margin of the wing presenting a straight edge, *c b*; *d e f*, anterior or thick margin of the wing.

Fig. 75. Left wing of Wild Duck, seen from behind and from beneath,—shows double curve made by the posterior or thin margin of the wing during complete extension: *c a*, posterior axillary curve, the convexity of which is directed downwards; *b a*, posterior distal curve with its convexity directed upwards (compare *c a* and *b a* of this figure with *b* and *c* of fig. 73, where the curves are reversed, as in partial flexion); *d e f*, anterior or thick margin of pinion. When the wing is fully extended, as in the present instance, and the down stroke is made, the air is seized by the concave tip of the wing (*f*), and passed along the concave under surface of the pinion until it arrives at *c*, where, the *concavity* becoming a *convexity*, the air is permitted to escape. The track along which the air is urged during the descent of the wing is very well shown at *f g* (*vide* arrows) of fig. 62, the air escaping at *g* under *c*.

Fig. 76. Diagram showing the course described by the fish in swimming. The fish, in swimming, contrary to the received opinion, throws itself into a double curve (*a*, *d*), the curves taking hold of the water and letting go or relieving each other alternately. When the tail is delivering the effective stroke, as indicated by the arrow running in the direction of *b*, the anterior portion of the fish (*d*) is reversing, as shown at *c*. These changes are effected with such rapidity that the fish appears to be in two places at the same instant; and hence the double spiral track figured. While the double curve is being formed, the fish is rotating upon its axis; so that it is literally screwing itself forward in two directions, viz. from side to side and from behind forwards.

Fig. 77. Diagram representing the double spiral track described by the feet of swimming-birds. When the right foot (*r*) is describing the *outside* of a curve from before backwards, and from within outwards (as represented by the arrow running from right to left) during the effective stroke, the left foot (*s*) is describing the *inside* of a similar curve (*vide* arrow proceeding from left to right), from behind forwards, and from without inwards, in the non-effective or back stroke. The feet thus coordinate each other; and as they reciprocate and alternate, the double spiral figured is obtained.

Fig. 78. Diagram showing the double spiral produced by the alternating of the extremities in man—the right leg (*r*) and left arm (*s*) advancing simultaneously and alternating with the left leg and right arm, which likewise advance together.

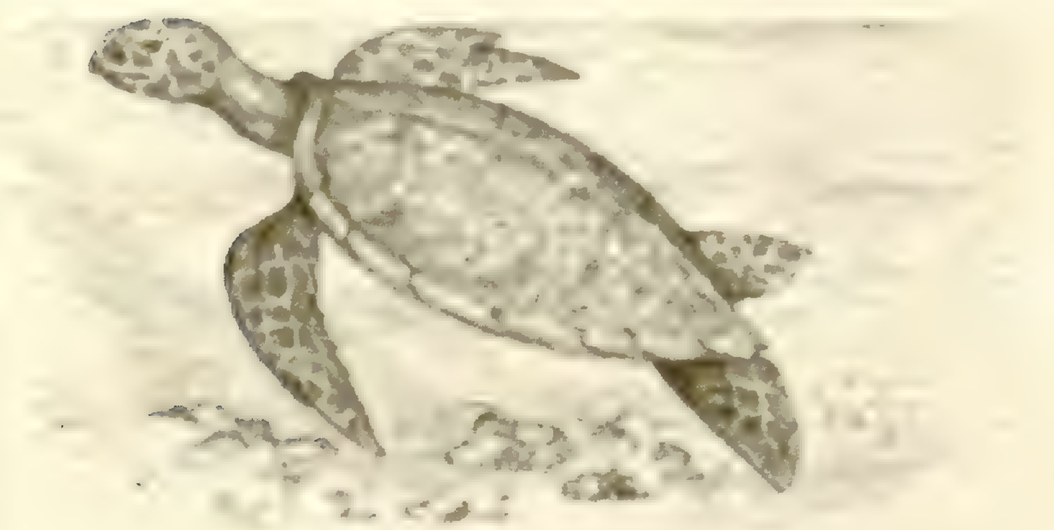

Fig 12

Vincent Brooks Imp

Charles Berjeau del et lith 1867

Fig. 25.

Charles Berjeau, del. et lith. 1867

Vincent Brooks Imp.

Vincent Brooks Imp

Fig. 44.

Fig. 45.

Fig. 46.

Fig. 47.

Fig. 48.

Fig. 49.

Fig. 50.

Fig. 51.

Fig. 52.

Fig. 53.

Fig. 54.

Fig. 55.

Fig. 56.

Fig. 57.

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Fig. 59.

Fig. 60.

Fig. 61.

Fig. 62.

Fig. 63.

Fig. 64.

Fig. 65.

Fig. 66.

Fig. 67.

Fig. 68.

Fig. 69.

Fig. 70.

Fig. 71.

Fig. 72.

Fig. 73.

Fig. 74.

Fig. 75.

Fig. 76.

Charles Berjeau, del et lith 1867

Vincent Brooks Imp

VI. *Fungi Angolenses.—A Description of the Fungi collected by Dr.* Friedrich Welwitsch *in Angola during the years* 1850–1861.

By Friedrich Welwitsch, *M.D., F.L.S., and* Frederick Currey, *M.A., F.R.S., Sec.L.S.*—Part I.

(Plates 17–20.)

Read April 18th, 1867.

The Fungi described in this paper were collected partly in Sierra Leone and the islands of Biafra Bay, but for the most part in Angola and Benguella. Some were found near the coast between 7° and 16° south latitude; but the greater portion occurred in the highlands of the interior (from 120 to 260 miles eastward), which in Angola attain a height of 4000, and in Benguella of 6000 feet above the sea.

The present can only be looked upon as a fragmentary contribution to the Mycology of Angola, inasmuch as, from the difficulty of travelling in so wild a country, and the continual predatory wars of the Negro tribes, it is rarely possible to remain long enough in one spot. At the same time we think that the many new forms here described are sufficient to justify the present publication; and, with the permission of the Linnean Society, we propose in a subsequent paper to give an account of the Hymenomycetes, which (especially the Polyporei) are rich in the number and variety of the species.

PHACIDIACEI, Fr.

Phacidium nitidum, Welw. & Curr. *Peritheciis* innatis, dimidiatis, interdum confluentibus, folii substantia concretis, orbiculatim dispositis, nigris, nitidis, in 3–4 lacinias latas dehiscentibus; *disco* nigro-olivaceo; *sporidiis* ovalibus vel irregularibus, nigro-fuscis, 0·0006 unciæ longis.

Hab. Frequens ad folia perennantia *Parinarii* in editis de Morro de Lopollo (5600 ped.), distr. Huilla. Januario 1860.

Obs. The specimens exhibit no asci, but only spores borne on sporophores. They are not in a satisfactory condition; and it is possible that the asci may have been absorbed, or that the plants are only in the stylosporous state.

SPHÆRIACEI, Fr.

Xylaria axillaris, Welw. & Curr. *Stromate* suberoso, nigro (sterili longiore et fragiliore); *peritheciis* irregulariter sparsis, globosis, mamillatis; *sporidiis* nigro-fuscis, elliptico-acuminatis, 0·0010–0·0013 unciæ longis.

Hab. Ad axillas ramulorum arboris e familia Artocarpacearum juxta ripas fluvii Coango, Golungo alto, Decemb. 1855. No. 79.

This plant somewhat resembles *X. hypoxylon*, var. *uviformis*, Mont.; but the perithecia are fewer, and the sporidia much larger.

Tab. 17. fig. 24, two specimens, × about 6 diameters; fig. 25, *sporidia*, × 420 diam.

X. arenicola, Welw. & Curr. *Stipite* fragili, elongato, nigro-fusco, profunde sepulto, 1–3 unc. longo; *capite* fusco, maculato, ostiolis minutis nigris scabro, $\frac{1}{4}$–$\frac{1}{2}$ unciæ longo, conico vel subcylindrico, apicem versus acuminato vel rotundato, aliquando leviter curvato; *peritheciis* nigris, subglobosis; *sporidiis* minutis, nigro-fuscis, cymbiformibus, 0·0002 unciæ longis.

Hab. Ad terram sabulosam humidam prope Cazella, Pungo Andongo, 2400–3800 ped. elevat., Januario 1857. No. 92.

Tab. 17. figs. 5 & 6, two plants, very slightly magnified, so as to show the *ostiola*, which are hardly visible without a lens.

X. aphrodisiaca, Welw. & Curr. Cæspitosa, *clavulis* subcylindricis, 1–2 unc. altis, fusco-cinereis, tota superficie inordinate areolatis; *medulla centrali* albissima; *peritheciis* ——? Basis communis tomento fusco delicato vestitur.

Hab. Rarior; in silvis primitivis densis ad truncos diu putrefactos, juxta rivum Delamboa, distr. Golungo alto, Januario 1856. No. 102.

Obs. The plant is considered an aphrodisiac by the negros.

Tab. 18. figs. 3 & 4, plants, natural size.

X. variabilis, Welw. & Curr. Simplex vel ramosa, 2–6 unc. longa, fuliginoso-atra, *peritheciis* ——?

Hab. Sparse ad truncos vetustos dejectos cariosos in silvis primitivis de Quisucula prope Bango, Golungo alto, Februario 1855. No. 104.

Obs. The specimens are barren. The inner tissue collapses in drying (as is the case with many *Xylariæ*), leaving the bark (so to speak) in the form of a brittle detached integument.

Tab. 18. fig. 7, plants, natural size.

X. hypoxylon, Fr.

Several specimens of this species were collected in different localities. Some are a little doubtful, as they exhibit no fruit.

No. 87. Ad truncos vetustos prope "Caverna de Salitre" in Sobado de Mussengue, Golungo alto, Maio 1855.

No. 88. Ad truncos emortuos in silvis primitivis montium de Muxâula, distr. Cazengo, Junio 1855.

No. 90. Ad truncos vetustos in silvis editis prope Puri-Cacarombola, Ambaca, Octob. 1856.

No. 91. Ad ramulos emortuos putrescentes in terra sepultos ad dextram rivi Delamboa, Decemb. 1855. These specimens are very imperfect.

No. 135. In silvis densis primitivis, maxime humidis, ad truncos putrescentes denso agmine crescens prope Bumbo, Mossamedes, Oct. 1859.

X. DIGITATA, Fr.

Hab. Ad truncos putrescentes in silvis primitivis ad basin de Serra de Xella prope Bumbo, distr. Mossamedes, Oct. 1859. No. 136.

No. 136*b* seems to be a slender form of the same species, but it may possibly be distinct. The plant is barren.

THAMNOMYCES HIPPOTRICHIOIDES, Ehrh.

Obs. We have some doubt as to this species. The specimen is quite barren.

Hab. Ad ramulos stantes Asparagi etc. prope Sange, distr. Golungo alto, Feb. 1855.

PORONIA CLAVIFORMIS, Welw. & Curr. Solitaria vel cæspitosa, nigro-fusca, stipitata, 5 lin. ad $\frac{1}{2}$ unc. alta; *stipite* apicem versus leviter incrassato, in discum aliquanto convexum peritheciorum ostiolis scabrum expanso; *perithecciis* ovalibus, pallidis (? immaturis), in stromate duro suberoso immersis, *ostiolis* prominentibus. *Sporidiis* ——?

Hab. In cryptis rupium ad ligna putrescentia, rara, Arimo de Salgado, Pungo Andongo, Decemb. 1856. No. 85.

HYPOXYLON SERPENS, Fr.

Hab. Frequens ad cortices ramorum putrescentium variarum arborum prope Bança de Muddingue, Golungo alto, Julio 1855. No. 81.

Obs. It is doubtful whether this is *H. serpens* or an effused form of *H. multiforme*, Fr. The perithecia are more crowded and more immersed than in the typical form of *H. serpens*.

H. SUBORBICULARE, Welw. & Curr. *Stromate* suborbiculari, $1\frac{1}{2}$–2 unc. lato, $\frac{3}{8}$–$\frac{5}{8}$ unciæ crasso, subtus leviter concavo, centro adfixo; superne plano vel plano-convexo et leviter undulato, intus favoso et albido, extus nigro, pulvere rubiginoso consperso; margine inverso et crassescente; *perithecciis* stipatis, immersis, stromatis faciem superiorem et marginem inversum colentibus; *ostiolis* prominentibus, papillatis; *sporidiis* nigro-fuscis, ellipticis vel cymbiformibus, 0·0005 unc. longis.

Hab. Juxta truncos vetustos in silvis inter Monino et lacum Ivantâla, Huilla, sed rarum, Martio 1860. No. 137.

TAB. 17. fig. 18, vertical section of a plant, natural size.

H. NUMMULARIUM, Bull.

Hab. Ad ramos emortuos in silvis de Serra de alta Queta, Golungo alto, Decemb. 1855. No. 93.

Obs. An effused form, with small sporidia. There is another specimen (No. 98) of this species, also an effused form, of which the habitat is "Ad truncos, prope Capopa, Golungo alto, Junio 1856."

H. AGGREGATUM, Welw. & Curr. Aquilum, late cæspitosum, sessile; individuis sphæroideis conico-rostratis vel irregulariter expansis plurima ostiola præstantibus. *Sporidia* —— ?

Hab. Ad truncos vetustos, totam eorum superficiem obtegens, prope Bumba, Golungo alto, Maio 1855. No. 94.

Obs. Allied to *Hyp. cœnopus*, Fr., but sessile.

TAB. 17. fig. 22, detached *perithecia*, magnified.

H. CETRARIOIDES, Welw. & Curr. *Stromate* decumbente, laciniato, habitu et crescendi modo *Cetrariam tristem* simulante; *laciniis* dilatatis, multifidis, apicem versus in perithecia transeuntibus; *peritheciis* dense aggregatis aliquando complanatis irregularibus, plurima ostiola præstantibus; *sporidiis* —— ?

Hab. Ad truncos magnos putrescentes in silvis primitivis prope Quilanga, Pungo Andongo, Aprili 1857: No. 97. Ad cortices arborum putrescentium in silvis primitivis prope Quibolo, Golungo alto, Aprili 1856: No. 80.*

Obs. This species is developed between the decayed bark and the wood. The lichenoid expansion of the stroma is probably due to the absence of light.

TAB. 18. fig. 5, a plant, natural size; fig. 6, one of the ramifications, magnified.

H. CONCENTRICUM, Bolt. ?

Not fully developed, exhibiting neither sporidia nor perithecia.

Hab. Sub cortice truncorum putrescentium in silvis primitivis prope Quilanga, distr. Pungo Andongo, Januario 1857.

H. ANGOLENSE, Welw. & Curr. Claviforme, nigerrimum, lucidum; *peritheciis* dense aggregatis, ostiolis minutis parum prominentibus; *sporidiis* nigro-fuscis, ovatis vel leviter curvulis, 0·0005–0·0006 unc. longis.

Hab. Ad corticem putrescentem, Quibolo, Golungo alto, Martio 1856. No. 103.

TAB. 17. fig. 19, plants, nat. size; fig. 20, sporidia, ×. In one of the plants the rudiments of a branch are seen.

H. USTULATUM, Bull., var. Sporidiis minoribus, 0·0005–0·0006 unc. longis.

Perhaps a distinct species; but the specimens are not satisfactory.

Hab. Gregatim, at rarum, ad truncos emortuos arborum (*Spondias* et affin.) prope Ponte de Felix Simões, Golungo alto, Nov. 1854. No. 101.

* A less perfect form.

H. RUBIGINOSUM, Fr.

Hab. Ad ramos emortuos dejectos in silvis de Serra do alto Queta, Golungo alto, Martio 1855. Nos. 82, 82 *b*.

H. SCOPIFORME, Mont.

Hab. Ad truncos vetustos in silvis editis (2500 ped.) in insula Principis, Sept. 1853 : No. 86. Quilombo Quiacatubia, Golungo alto, Februario 1855 : No. 89.

H. ANNULATUM, Fr., β. *depressum*. *Sporidiis* fuscis, strictis, irregulari-ovalibus, 0·0003 unc. longis.

Hab. Ad truncos vetustos in silvis calidioribus prope Puri Cacarambola, Ambaca, Octob. 1856 : No. 83. No. 69 ad truncos vetustos cariosos prope Cabinda, Ambaca, Octob. 1856.

No. 84 seems to be the same species, but in an exolete condition.

SPHÆRIA LANARIS, Welw. & Curr. (Confertæ). *Perithecciis* conicis vel subglobosis sub epidermide nigrefacta in acervos vel tubercula irregulariter stipatis, *ostiolis* minutis prominentibus ; *stromate* fusco, lanuginoso, e folii substantia formato ; *sporidiis* 1–2-seriatis, pallidis, ellipticis vel subpyriformibus, 0·0006–0·0007 unciæ longis, interdum 1–2-nucleatis.

Hab. Ad folia variarum specierum *Fici* prope Sange, Golungo alto, Novemb. 1854 : No. 74. Ad folia viva *Fici*, Sangue, Golungo alto, Maio 1855 : No. 75. Frequens ad folia vetustiora *Fici*, Quibige, Golungo alto, Decemb. 1855 : No. 76.

S. BOMBARDA, Batsch.

Hab. Ad ligna cariosa in silvis primitivis de Quisucula, prope Bango, Golungo alto, Aprili 1856. No. 95.

DOTHIDEA ——? Statu stylosporifero. Erumpens, difformis, sinuosa, cæsio-atra ; *stylosporis* late ovatis, pallidis vel leviter luteolis, 0·0006 unc. longis.

Hab. Ad truncos semiemortuos arboris ex Artocarpacearum familia in silvis editis, Sobati de Quilombo Quiacatubia, Golungo alto, Januario 1856. No. 96.

PEMPHIDIUM NOBILE, Welw. & Curr. *Perithecciis* sparsis, solitariis vel 2–3 conjunctis, dimidiatis, basin versus matrice concretis, *ostiolo* nudo, subconico, deciduo, prominente, pertuso, annulato-marginato ; *sporidiis* 1-seriatis (?), oblongis, nigro-fuscis, 1-septatis, ad septum leviter constrictis, interdum inferne angustatis, 0·00010–0·00011 unc. longis.

Hab. Ad petiolos foliorum palmarum (*Elais guineensis*) prope rivum de Capopa, Golungo alto, Junio 1856. No. 60.

TAB. 17. fig. 12, *sporidia*, × highly ; fig. 13, a *perithecium*, × slightly.

MICROPELTIS ——? *Sporidiis* biserialibus, hyalinis, uniseptatis, leviter curvatis, utrinque acuminatis.

Hab. Ad folia plantæ acaulis monocotyledoneæ, Mata de Quisucula, prope Banjo, Golungo alto, Julio 1857. No. 13.

Obs. The specimens are not in good condition ; so that the description is necessarily imperfect.

PERISPORIACEI, Fr.

Meliola formosa, Welw. & Curr. *Mycelio* procumbente, effuso, implicato, pinnato, nigro-fusco, setis sparsis erectis obsito; *peritheciis* globosis, demum profunde depressis, cupulatis; *sporidiis* pallidis, elongato-ellipticis vel leviter curvatis, 3–4-septatis, 0·0006 unc. circiter longis.

Hab. Ad folia, Quibolo, Golungo alto, Aug. 1856. No. 40.

Tab. 17. fig. 1, a branch of the mycelium, slightly × ; fig. 2, setæ, *id.*; fig. 3, spores, highly × ; fig. 4, fragments of the mycelium, × 420 diam.

Obs. The specimens exhibited only a few detached sporidia, which appeared to be produced from the perithecia; so that the description of the fruit is doubtful. The specimens are not in good condition. The outer coat of the perithecia appears to be formed by the curling round and approximation of the ramifications of the threads of the mycelium, within which outer coat a membrane is afterwards formed. It is not clear whether or not the curling threads sprang from the tips of the sides of the branches. The large swellings in the threads exactly resemble the spores of some *Helminthosporia*, and frequently break off from the mycelium and become free during examination under the microscope, so that in the absence of perithecia the plant might easily be taken for a *Helminthosporium*.

Asterina difformis, Welw. & Curr. *Peritheciis* orbicularibus vel irregularibus complanatis, *filis* fuscis (e tota peritheciorum superficie orientibus et ad basin super folium radiatim extensis) amictis; *ascis* rotundatis vel obovatis; *sporidiis* biserialibus, obovatis, pallidis, 1-septatis, ad septum constrictis, 0·0005 unc. longis vel rarius 0·0007 unc. æquantibus.

Hab. Ad folia viva fruticis Menispermacearum in silva primitiva "Mata do Pungo," Pungo Andongo (2400–3800 ped. elevat.), Decemb. 1856. No. 39.

Tab. 17. fig. 21, *asci* and *sporidia*, × 420 diam.

Obs. We are uncertain whether or not the perithecium is formed of the substance of the leaf.

Eurotium herbariorum, Lk.

Hab. Ad folia fruticis scandentis ex ordine Apocynacearum in silvis primitivis prope Sange, Golungo alto, Feb. 1855. No. 152.

SPHÆROPSIDEI, Leveill.

Pestalozzia depazeoides, Welw. & Curr. Macula oblonga, grisea, $\frac{3}{4}$ unc. longa, margine fusco; *peritheciis* minutis, nigris, macula insidentibus; *sporis* pallide fuscis, simplicibus vel 1-septatis, setis tribus longis coronatis; *sporis* (sine appendicibus) 0·0005–0·0006 unc. longis.

Hab. Rarius ad folia *Fici andongensis*, Welw., in summis jugis rupium Præsidii (Pedra de Cazella), Pungo Andongo, Decemb. 18, 1856. No. 17.

Tab. 17. fig. 14, spores, × highly.

PHYLLOSTICTEI, Fr.

PHOMA CONFLUENS, Welw. & Curr. *Peritheciis* spuriis e substantia folii formatis, rotundatis, vel elongatis et irregularibus, in tubercula nigra rugosa minuta confluentibus; tuberculis approximatis, acervos latos (1–2 unc. longos) formantibus; *nucleis* biformibus, altero e tela floccosa sporas nudas gerente constante, altero ascigero; *sporidiis* oblongis, pallidis, biseriatis, 1-septatis, 0·0007 circiter unciæ longis.

Hab. Ad foliola fruticis scandentis Leguminosarum floribus paniculatis albis, Golungo alto, Aug. 1856. No. 63.

TAB. 17. fig. 16, *perithecia*, × ; fig. 18, *sporidia*, × highly.

Obs. The naked spores resemble sporidia, but are more irregular in shape. Perhaps this plant ought to form a new genus; but new genera ought not be hastily proposed, especially in such a family as the Phyllostictei.

ISOTHEA RHYTISMOIDES, Fr., vel proxima species.

Hab. Ad folia spec. *Fici* in silvis de Monino, Huilla, Maio 1860. No. 141.

I. MINUTISSIMA, Welw. & Curr. *Nucleo* pallido, e filamentis ascis subclavatis intermixtis formato; *sporidiis* monostichis vel distichis, irregulariter ellipticis, hyalinis, 0·0005 unc. circiter longis.

Hab. Ad folia *Peniseti gigantei*, Benth., prope Cangunho, Golungo alto, Sept. 1855. No. 31.

Obs. We do not know where to place this plant, if not in the genus *Isothea*, although the nucleus there is defined as "*coloratus*." It would be absurd to form a new genus on the absence of colour. The plant forms excessively minute black specks of irregular shape (being the discoloured epidermis), sometimes pierced in the centre with a circular pore.

I. IRREGULARIS, Welw. & Curr. *Nucleis* segregatis vel conjunctis (siccitate pallido-fuscis), his maculas nigras irregulares 1 lin. (plus minus) longitudine mensurantes, illis maculas minutas rotundatas conicas formantibus; *ostiolis* prominentibus, mamillatis; *ascis* subelongatis et strictis; *sporidiis* oblique monostichis, ellipticis, granulosis, 0·0006 unc. longis.

Hab. Ad folia arboris ignotæ, Alta Queta, Gulungo alto, Martio 1856. No. 2.

DEPAZEA, Fr.

Several plants, apparently belonging to this genus, occur in the collection. They are, however, all barren, and the specific names therefore indeterminable. The following is a short account of them.

No. 24. Ad foliola speciei *Eriodendri*, prope Capope, Golungo alto, Septembri 1855.

No. 30. Ad folia speciei *Alsodeiæ*, Golungo alto, Junio 1855.

Obs. A very doubtful plant, in an unsatisfactory condition.

No. 23. Ad folia vetusta speciei *Bauhiniæ*, in dumetis campestribus prope Izanga et Ngombe, Ambaca, Octobri 1856.

No. 3. Ad folia speciei *Hippocrateæ* in silvis de Capopa, Golungo alto (1000–2400 ped. elèvat.), Aug. 1855.

No. 14. Ad folia fruticis ex ordine Hippocrateacearum prope Luxillo, Pungo Andongo, Novembri 1856.

No. 15. Non frequens, ad paginam superiorem foliorum fruticis ex ordine Hippocrateacearum, Luxillo, Pungo Andongo, Novembri 1856.

No. 65. Ad foliola arboris e familia Spondeacearum, (Munguenga) Golungo alto (1000–2400 ped. elevat.), Februario 1856. Planta minutissima.

No. 78. Ad frutices prope Præsidium, Pungo Andongo, Februario 1857.

No. 77. Ad folia *Bandeirææ speciosæ* in collinis dumetosis ad rivum Delamboa, Golungo alto, Aug. 1855.

CRYPTOSPORIUM CIRCINANS, Welw. & Curr. *Peritheciis* stipatis, subglobosis vel irregularibus, in circulis concentricis dispositis; *sporis* pallidis, subclavatis vel subfusiformibus, leviter curvatis, longitudine variis, 0·0006 unc. assequentibus.

Hab. Frequens ad folia fruticis spinosissimi e Capparidearum familia in dumetis prope Loanda, Januario 1854. No. 64.

Obs. The circles of perithecia are sometimes confluent, entirely concealing the under surface of the leaf. Some of the perithecia open with a rimose dehiscence, showing an affinity with *Labrella*.

SEPTORIA CRUSTACEA, Welw. & Curr. *Peritheciis* minutissimis, crusta nigra, in acervos multiformes confluentes ostiolis minutis punctiformibus obsitos compactis; *sporis* filiformibus, tenuibus, pallidis, longitudine variis.

Hab. Ad folia arboris familiæ Artocarpearum, Trombeta, Golungo alto, Octob. 1856.

Obs. Under a lens, the plant looks exactly like some effused *Hypoxylon*.

PHALLODEI, Fr.

PHALLUS TUNICATUS, Schlecht. Linnæa, vol. xxxi. p. 123.

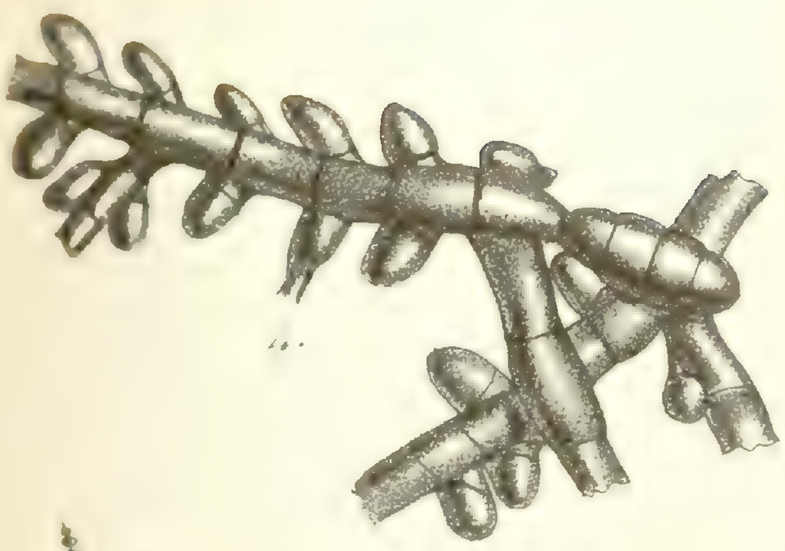
Hab. Ad terram humosam in silvis densis de Serra de Alta Queta, tempore pluvio, Aprili 1855. Rarissime obvius. Annis 1854–57 tria tantum specimina observata fuerunt. No. 121.

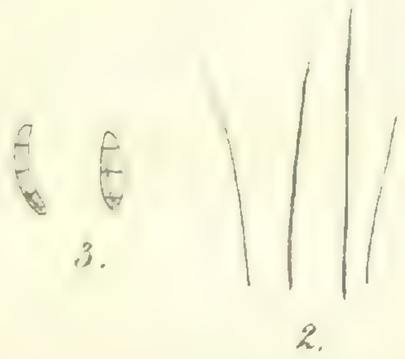
Obs. The specimens are not perfect, the veil being much broken, so that there is some doubt about the species; but it accords well (as far as can be judged) with *Ph. tunicatus*, Schl. This species seems to have been rightly separated by Schlechtendal from the *Ph. indusiatus* of Ventenat, figured in Mém. d. l'Inst. Nat. i. p. 520, tab. vii. f. 3. A comparison of the latter figure with that in the Dict. d. Sc. Nat. Champignons, tab. 7, figs. 1, 1*a*, 1*b*, will show that the two plants are very different.

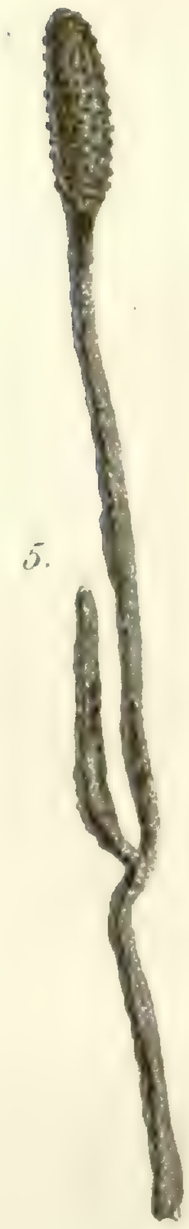
LATERNEA ANGOLENSIS, Welw. & Curr. *Peridio griseo, fusco maculato*, crassissimo, gelatina farcto; *receptaculi* ramis quatuor, splendide albidis, apice connatis; *strato mucoso* fusco-atro, odoris vini fermentescentis.

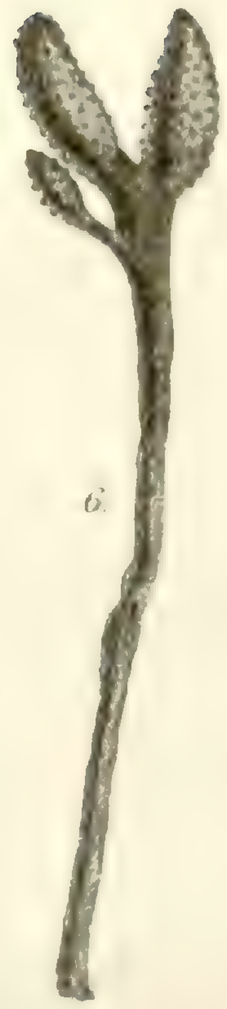
Hab. Ad rupes arenaceas humo tectas ipsius Præsidii, prope Catete, Pungo Andongo, 10 Dec. 1856. No. 120.

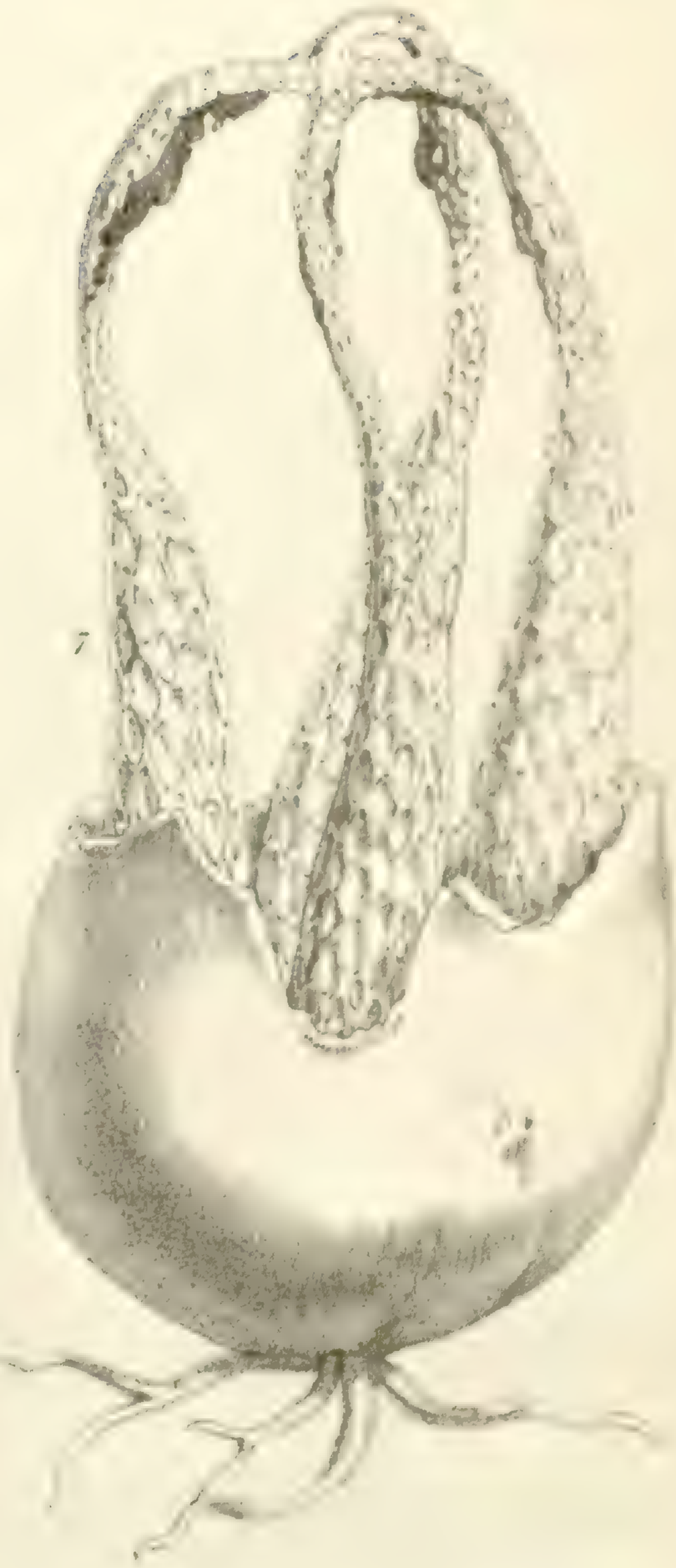
TAB. 17. fig. 7, the plant, natural size, after a sketch taken on the spot.

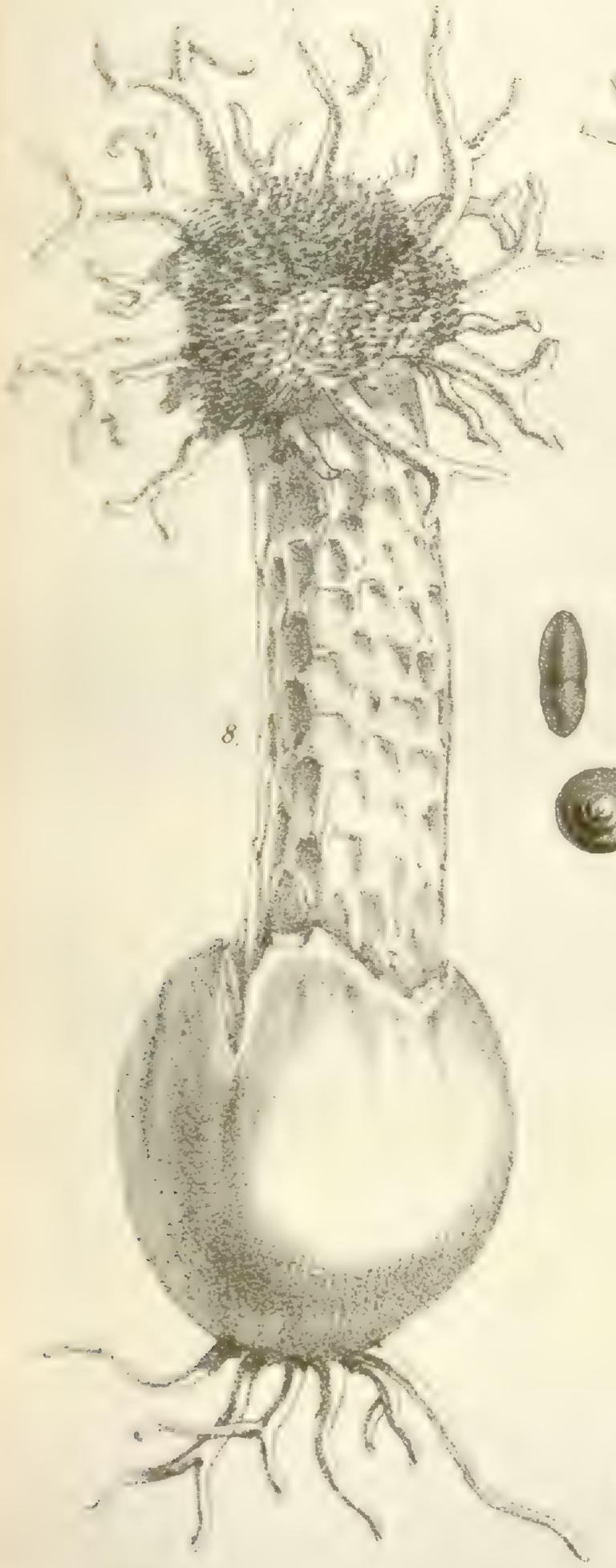


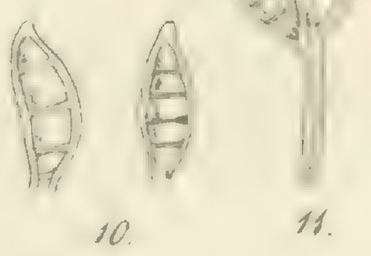


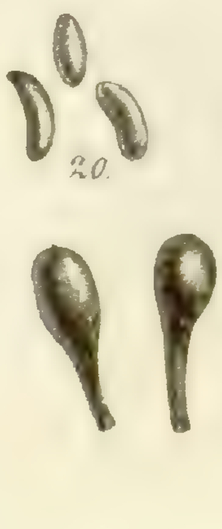












F.W.F.L. & W.F. del. et. lith

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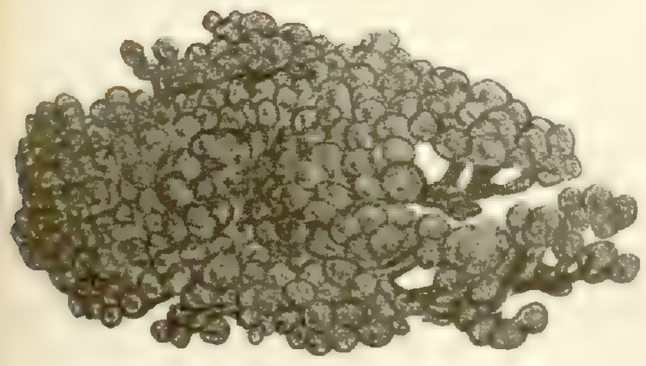

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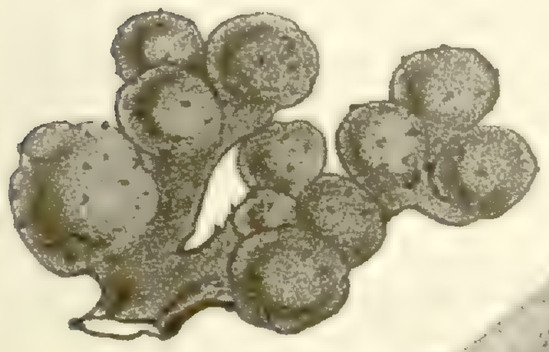

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F.C.& W.F. del. et lith.

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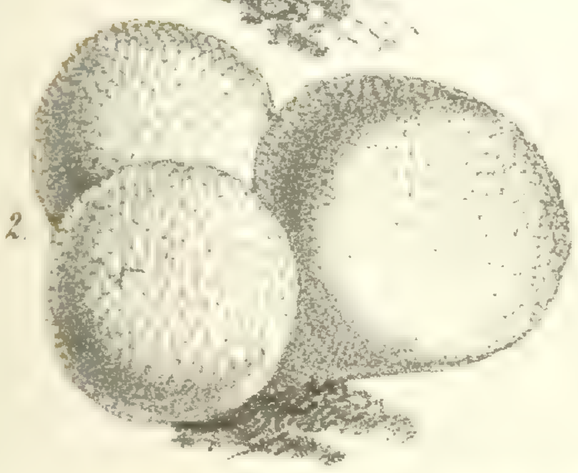

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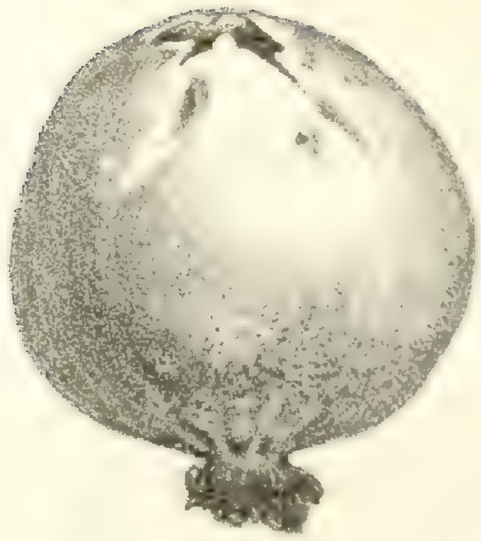

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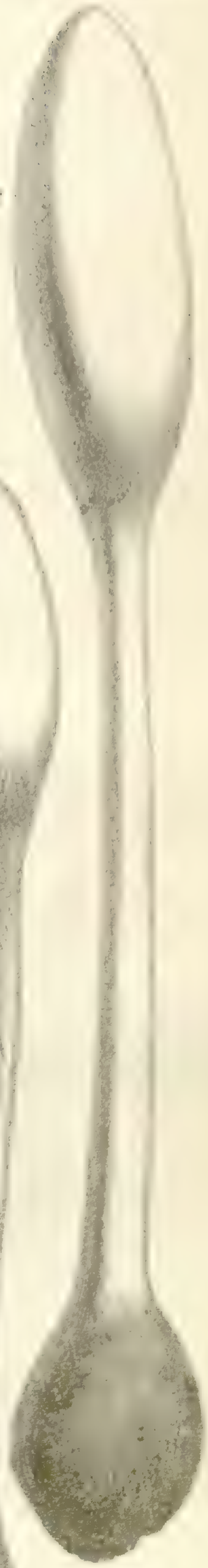

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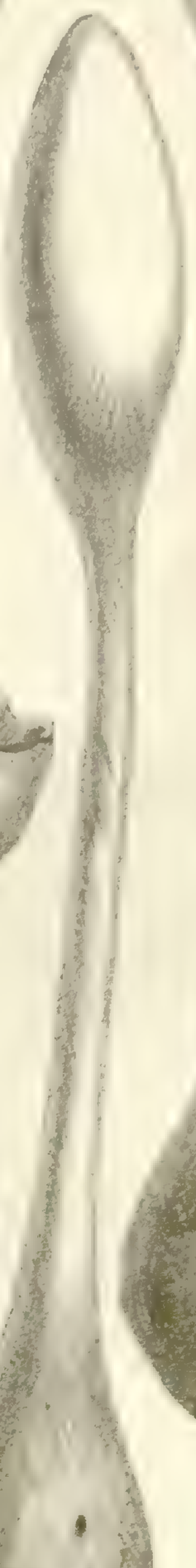

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W.F. del et lith.

J.N. Fitch imp

Obs. A single specimen, gathered in fine weather. This species is manifestly nearly allied to *Laternea columnata*, Bosc, but differs in the colour, and apparently also in the form of the ramifications of the receptacle, as well as in the smell (not fetid) of the *stratum mucosum*.

Lysurus corallocephalus, Welw. & Curr. *Utero* ovoideo, basi fibris albicantibus stipitato; *strato gelatinoso* crasso, distento, stipite increscente irregulariter dehiscente, extus ex albido cinerascente, intus albido lævigato; *stipite* cylindrico, cavo, albo, spongioso, poroso-reticulato, fragili, apice membrana carnoso-spongiosa coccinea rugulosa oblique clauso, duabus tribusve foraminibus parvis subcircularibus excentricis relictis. Hac ex membrana ramenta crebra complanata transverse rugulosa divaricatim dichotoma ramosa undique surgunt, ex basi ad medium usque circa-circum strato mucoso viscido fœtido tecta, apicibus belle coccineis, varie flexis, emersis, nudis, coralliformibus, cito collabentibus.

Hab. Inter *Zeæ Maydis* plantationes, solo arenoso-argillaceo humidiusculo, tempore sereno, 3 dies post pluvias frequentes, itaque nec cœlo tonante, nascens, in Præsidio, Pungo Andongo, unicum specimen, Dec. 10, 1856. No. 119.

Tab. 17. fig. 8, plant, of the natural size, after a sketch taken on the spot.

Obs. The coral-like ramifications become much contracted in drying. This plant is more nearly allied to *Lysurus* than *Aseroe*, although it differs from the species of *Lysurus* hitherto described in having a perforated membrane. It may be doubtful whether there is any substantial difference between the genera *Lysurus* and *Aseroe*. It would seem, from this specimen, that in *Lysurus* the apex of the receptacle is not always entirely closed. The perforations of the membrane do not afford a sufficiently marked character for the formation of a new genus.

NIDULARIACEI, Fr.

Cyathus striatus, Hoffm.

Hab. Sparsim ad ligna putrescentia in silvis primitivis humidis prope Præsidium, Pungo Andongo. Februario 1857: No. 113. Ad ramulos dejectos inter folia putrescentia in apricis cultis neglectis prope Sansamanda ad ripas fluminis Cuanza, Pungo Andongo, Martio 1857: No. 114.

LYCOPERDACEI, Fr.

Geaster fimbriatus, Fr.

Hab. Rarius ad terram juxta rivulum de Casalalé, in Præsidio Pungo Andongo, Decemb. 1856. No. 108.

G. mirabilis, Mont. Sylloge, p. 286; Ann. d. Sc. Nat. ser. iv. vol. iii. p. 139, t. 6. f. 8. *Sporis* minutissimis, vix 0·0001 unc. superantibus, sub microscopio pellucidis.

Hab. Rarissimus, ad truncos putrescentes in silvis primitivis de Quisucula et prope Casengue, Golungo alto, Aprili et Augusto 1850. No. 107. Primum in Guyana Gallica a clar. Leprieur ad Cayennam observatus.

PODAXON LOANDENSIS, Welw. & Curr. *Stipite* duro, lignoso, semipedali (vel fere 8 poll. alto), fibroso, torto, intus ex aurantiaco flavo, subtiliter fibrilloso, siccitate fusco, basi bulboso; *peridio* obovato, elliptico, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longo, membranaceo, albido, ruguloso, apice obtusiusculo; *capillitio* primum albido, quasi molliter caseoso, subcarnosulo, dein floccoso flavo, demum ex tabacino nigrescente; *sporis* transparescentibus, junioribus nitido-flavis, maturescentibus fuscis, globosis, ellipticis vel subturbinatis, 0·0004–0·0006 unciæ longis.

Podaxon loandensis, Welw. Apont. Flor. Angol. p. 535 (Lisbon 1858).

Hab. Frequentissime in pascuis breviherbidis arenosis juxta oceani littus Angolense, prope Penedo agri Loandensis. Paulo post primas pluvias adparet et ad Maii finem usque nova semper individua progignuntur. No. 115.

TAB. 20. figs. 5, 6, 7, plants, of the natural size.

P. MOSSAMEDENSIS, Welw. & Curr. 5–9 unc. altus, *stipite* æquo vel apicem versus attenuato, hic illic rubro tincto, firmo, lignoso, ad basin bulboso; *peridio* conico vel oblongo, 2–4 unc. longo, $1\frac{1}{4}$–$2\frac{1}{4}$ unc. lato, siccitate flavescente aut nigro-fusco et longitudinaliter rugoso; *sporis* nigro-fuscis, numerosissimis, globosis vel subturbinatis, et tunc pediculo minutissimo aliquando ornatis, 0·0004 unc. circiter diametro; *capillitio* fusco, sporis aliquanto pallidiore, simplici (*i. e.* non spiraliter lineato).

Hab. Sporadice in dumetosis arenosis ad ripas fluvii Maiombo, distr. Mossamedes, Oct. 1859. No. 149.

TAB. 17. fig. 23, spores, × highly.

TAB. 19. figs. 1, 2, plants, of the natural size; fig. 3, a plant (nat. size) with the *peridium* removed, showing the *capillitium*.

There is a plant numbered 149 *a*, as to which we have some doubt, but which is probably a small form of this species. The habitat is:—"In pratis et pascuis arenosis maritimis prope Loandam, Dec. 1853, Feb. 1858."

P. ELATUS, Welw. & Curr. 6–13 unc. altus, stipite lignoso, durissimo, $\frac{1}{2}$–$\frac{3}{4}$ unc. lato, æquo, basi curvato, e mycelio arachnoideo cartilagineo subaurantiaco emergente; *peridio* elongato-ovato, 3–8 unc. longo, apice rotundato vel acuminato, vegeto albido, siccitate fusco; *sporis* (junioribus) flavis, dein fuscis, ellipticis, sæpissime uno extremo truncatis, 0·0004 unc. longis; *capillitio* flavo vel subolivaceo, membrana lineis spiralibus confertis obscure signata et fracturam spiralem exhibente.

Hab. Sparsissime in silvis arenosis mixtis (*i. e.* e *Proteæ, Eugeniæ, Strychni, Acaciæ, Cæsalpiniæ* etc. speciebus conflatis) inter Lopollo et Monino, Januario 1860. No. 148.

TAB. 19. figs. 4 & 5, plants, of the natural size; fig. 6, a fragment of a thread of the *capillitium* spirally ruptured.

Obs. The spiral markings are not visible in all the threads of the capillitium; probably they vary according to age.

LYCOPERDON TOMENTOSUM, Welw. & Curr. *Peridio* globoso vel subturbinato, corneo, fragili, nigro-purpureo, tomento denso rufo separabili ex omni parte amicto; *capil-*

litio fusco; *sporis* fuscis, minutis, 0·0001 unc. vix superantibus, globosis, echinulis minutissimis obsitis.

Hab. Sporadice ad terram humosam inter folia putrida in silvis primitivis de Quisucula prope Bango, distr. Golungo alto, Feb. 1855. No. 117.

Tab. 19. figs. 7 & 8, plants, of the natural size.

Obs. The spores are so minute that, without careful observation and a high power of the microscope, they might be supposed to be smooth.

L. golungense, Welw. & Curr. *Peridio* globoso vel obovato, tomento delicato fastigiato amicto, e mycelio denso concolori nascente; *capillitio* ——?; *sporis* ——?

Hab. Ad basin truncorum putrescentium in silvis editissimis montis dicti Cungolungulu, Golungo alto, Feb. 1855. No. 118.

Tab. 20. fig. 13, plants, of the natural size.

Obs. These specimens are unripe, exhibiting neither capillitium nor spores.

L. radicatum, Welw. & Curr. Subturbinatum, radicatum, 3–4 unc. altum, 2–4 unc. latum; *peridio* papyraceo, fragili, plumbeo-ferrugineo, hic illic in vetustate subpurpurascente; *capillitio* obscure lilacino; *sporis* concoloribus, globosis, echinatis, 0·0002 unc. latis.

Hab. Rarissime, in pascuis graminoso-dumetosis prope Penedo, distr. Loanda, Martio 1854. No. 116.

Tab. 20. figs. 8 & 9, old plants, of the natural size.

L. asperrimum, Welw. & Curr. Subglobosum, 1 unc. circiter altum; *peridio* cinnamomeo, papyraceo, statu juniore spinis asperrimis demum caducis obsito; *capillitio* subrubiginoso; *sporis* capillitio concoloribus, globosis, 0·00015 unc. diametro, minutissime echinatis.

Hab. In dumetosis arenosis ad marginem de Lagoa de Giraul, distr. Mossamedes, locis subsalsis, Julio 1859. No. 142.

Tab. 20. fig. 14, plants, of the natural size.

Obs. The spines of the spores are so minute that they are seen with difficulty even under a high power.

No. 144 seems to be the same species, but exhibits no spines on the peridium. The peridium, however, is larger, and the spores reach 0·0002 inch. The habitat is:—"In arenosis graminosis prope Maiombo, distr. Mossamedes, Oct. 1859."

No. 144 is shown in Tab. 20. figs. 3 & 4.

L. cæspitosum, Welw. & Curr. Subglobosum, $\frac{1}{4}$–$1\frac{1}{2}$ unc. altum, $\frac{1}{4}$–$1\frac{1}{2}$ unc. latum, radicatum, vivum niveum, siccitate flavido-albidum, papyraceum, primo verrucosum, demum subnudum; *capillitio* argillaceo-lilacino, sub lente flavido; *sporis* argillaceo-lilacinis, globosis, lævibus, 0·0001–0·0002 unc. diametro.

Hab. In graminosis macris editis de Morro de Lopollo, distr. Huilla, gregatim crescens, Aprili 1860. No. 145.

Tab. 20. figs. 1 & 2, plants, of the natural size.

L. BICOLOR, Welw. & Curr. Stipitatum, $1\frac{1}{2}$–2 unc. altum, stipite albido, subcylindrico, basi attenuato; *peridio* plumbeo-fusco, papyraceo; *capillitio* fusco; *sporis* fuscis, globosis, lævibus, 0·0001–0·0002 unc. diametro.

Hab. In pascuis humidiusculis silvaticis inter Lopollo et Empalanea, distr. Huilla, Maio 1860. No. 146.

Tab. 20. fig. 12, plants, of the natural size.

With the Lycoperdons above described there is one unripe specimen (No. 143) which seems to be an undescribed species. It is subglobose, about 1 inch high, with a horny peridium irregularly areolated. It is too immature to deserve a specific name. The habitat is:—"In dumetosis arenosis prope Vicum Nene, Huilla, Maio 1860."

TULOSTOMA ANGOLENSE, Welw. & Curr. Albidum, $1\frac{3}{4}$ unc. altum, *stipite* ab apice ad basin sensim diminuente; *peridio* subgloboso (ore imperfecto); *capillitio* ferrugineo; *sporis* ferrugineis, subglobosis vel subellipticis, 0·0002 unc. diametro.

Hab. In collinis arenosis hic illic Euphorbiis cactiformibus obsitis ad austrum vici de Mossamedes, ast rarissimum, Julio 1857. No. 147. Jove pluvio forsitan frequentius.

Tab. 20. figs. 10 & 11, plants, of the natural size.

Obs. Possibly not distinct from *Tulostoma Meyenianum*, figured in Nov. Act. Leop. xix. Suppl. i. t. 5; but it is much smaller than that species, and differs in not having the longitudinal furrows on the stem.

SPHÆRICEPS, n. g. *Stipite* cylindrico, dure fibroso, firmo, ex albido badio, centrali, ubique æqualiter farcto, quidquam longitudinaliter striato; *peridio* albo, lævigato, sphærico, medio, ut videtur, orbiculatim dehiscente, nec vertice aperto; *capillitio* partim filiformi, partim membranaceo-expanso, elateribus intermixtis; *sporidiis* copiosissimis, ferrugineis, globosis vel subglobosis, 0·0002 unc. diametro.

Unica species:—

SPHÆRICEPS LIGNIPES, Welw. & Curr.

Characteres generis.

Hab. In dumetis arenosis, præcipue e *Tamarice articulata*, Vahl, conflatis, ad ripas flum. Caroca prope Cabo Negro, circa 16° lat. austr., circa 12 mil. ab oceano, Sept. 1859. No. 150.

Tab. 18. fig. 2, a plant of the natural size. Fig. 1 shows the underside of the same plant. In fig. 1 it will be observed that the stem has been slightly shortened for the convenience of the plate.

MYXOGASTRES, Fr.

STEMONITIS FUSCA, Roth.

No. 112. Ad folia vegeta *Jussiææ* spec. juxta rivulum Quiapoza, Golungo alto, Decemb. 1855.

No. 109. Ad caudices emortuos et ad folia viva *Musæ sapientum* prope fluvium Luinha cultæ, Januario 1855, distr. Cazengo.

No. 110. Ad ligna cariosa in silvis primitivis de Quisucula prope Bango, Golungo alto, Aug. 1857.

No. 111. Ad cortices dejectos in silvis humidis de Serra de Alto Queta, Golungo alto. Decemb. 1855.

Obs. All these plants approach the variety of *Stemonitis* known as "*typhoides*;" but the peridia are more crowded than in the typical *Stemonitis fusca*, var. *typhoides*.

ARCYRIA INCARNATA, P.

Hab. Ad corticem truncorum annosorum in silvis de Alto Queta, Golungo alto, rarissime obvia. No. 122.

Obs. We have some doubt about the plant; but it appears to be an *Arcyria*, and, if so, must, we think, be the above species.

SPOROCYBACEI, Fr.

STILBUM ATERRIMUM, Welw. & Curr. Minutum, cæspitosum, totum aterrimum, *capitulo* obovato vel clavæformi; *stipite* complanato; *sporidiis* ovalibus, hyalinis. 0·0002 unc. longis.

Hab. E rimulis corticum vetustorum arborum putrescentium generis *Fici* erumpens, in silvis ad Quibongo, Golungo alto, Aprili 1855. No. 52.

S. SERICEUM, Welw. & Curr. *Stipite* rigido, fusco-virescente; *capitulo* sphærico, vivo carneo-rubro, siccitate armeniaco; *sporis* ovalibus, hyalinis, 0·0002 unc. longis.

Hab. Ad *Zygiam fastigiatam* in silvis, Alto Queta, Golungo alto, Januario 1856. No. 49.

Obs. The stem is by no means villous; but under an inch power of the compound microscope it sometimes appears to have a very slight silky down.

S. CÆSPITOSUM, Welw. & Curr. Minutum, vegetum roseum, siccitate cinnamomeo-fuscum, cæspitosum, acervis gregariis aliquando dense aggregatis; *stipite* simplici vel dichotomo; *capite* globoso vel subgloboso; *sporis* irregulari-ovalibus, hyalinis, 0·0003 unciæ longis.

Hab. Ad truncos vetustos *Fici* prope Canguerasange, Golungo alto, tempore pluvio, Nov. 1854: No. 50. Ad truncos putrescentes *Ficorum* in silvis humidis Sobati de Quilombo Quiacatubia, Golungo alto, Februario et Maio 1855: No. 50*b*. Ad corticem var. *Fici* specierum, frequentissimum tempore pluvio prope Lopollo, distr. Huilla, Februario 1860: No. 131.

MUCEDINES, Fr.

PENICILLIUM GLAUCUM, Lk.

Hab. Nimis frequens in superficie atramenti, in forma pelliculæ glauco-flavescentis, jove pluvio, Loanda, Novemb. 1857. No. 38.

HAPLOTRICHUM CAPITATUM, Link.

Hab. Rarius ad folia *Celastri* spec., prope Calunga, Pungo Andongo, Jan. 11, 1857. No. 48.

HYMENULACEI, Fr.

HYMENULA VULGARIS, Fr. Forma rosea.

Hab. Ad folliculos Apocynacearum prope Luxillo, Pungo Andongo, Jan. 1857. No. 20.

SCLEROTIACEI, Fr.

SCLEROTIUM STIPITATUM, Berk. & Curr., Trans. Linn. Soc. vol. xxiii. pp. 91, 93.

Hab. Ad radices arborum emortuarum, sub terra ad profunditatem 1–3 ped. absconditum, in arvis *Solano tuberoso* cultis, prope Lopollo, Huilla, Apr. et Maio 1861. No. 138.

Obs. In India this species has hitherto been found only in the nests of the white ant.

S. FLAVIDUM, Welw. & Curr. Tubercula varia, subglobosa, reniformia vel deformia, flavida vel fulva, a mole grani sinapis (vel minus) ad pisi parvuli crassitudinem varia.

Hab. In declivis parce graminosis, ad 800–1000 ped. altitudinis, locis humidiusculis ad oras silvarum primitivarum ad terram inter cæspites putrescentes, Insula Principis in sinu Benin, Sept. 1853. No. 27.

Under No. 37 we find *Panicum plicatum* bearing an Ergot of the kind common in other grasses. As there is no fruit on the Ergot, we can only place it here amongst the Sclerotiacei. It would doubtless, at the proper season, produce some species of *Claviceps*.

SPORIDESMIACEI, Fr.

SPORIDESMIUM CELATUM, Welw. & Curr. Foliicolum, mycelio sub folii cuticula nigrefacta dense compacto; sporæ fuscæ, leviter curvatæ vel fere rectæ, 3–5-septatæ, interdum substipitatæ, pedicello pallidiore.

Hab. Ad folia plantæ e familia Euphorbiacearum, Coango, Golungo alto, Octob. 1855. No. 77.

TAB. 17. fig. 15, spores, highly magnified.

Obs. The place and mode of growth are somewhat unusual for a *Sporidesmium*, but the characters are not sufficiently definite for the formation of a new genus.

DEMATIACEI, Fr.

HELMINTHOSPORIUM CORDLÆ, Welw. & Curr. Epiphyllum, sistens maculas circulares, 1–4 lin. diam., fuscescentes, hic illic confluentes, e filis rigidulis crispulis exarticulatis parce ramosis fusco-luteis conflatas; *ramulis* patentissimis, plerumque leviter curvatis, crassitudine filamenta primaria æquantibus, ad basin hic illic fructiferis; *sporis* rectis vel curvulis, ellipsoideo-cylindricis, obtuse apiculatis, filamentis duplo crassioribus, 3–5-septatis, pellucidis.

Hab. Ad paginam superiorem foliorum *Cordiæ* spec. in silvis primitivis prope Sange, Golungo alto, Martio 1856. No. 1.

TAB. 17. figs. 9, 10 & 11, filaments and spores, × highly.

UREDINEI.

ÆCIDIUM.

A few *Æcidia* were collected, to which we do not venture to give specific names. Fries remarked long since (Syst. Myc. iii. 512) :—"*Æcidium* in singula planta describere

immensus esset labor, et omne eorum studium, haud mere physiologicum, mihi saltem, irritum visum est;" and Tulasne (Ann. d. Sc. Nat. ser. iv. vol. ii. p. 174) speaks of *Ecidium* as "genus vulgatissimum . . . . . plantis permultis et diversissimis infestum, e formis numerosissimis at vix dissimilibus, plerisque enim non nisi sede seu matrice sibi propria distinguendis." The recent observations of De Bary tend to show that *Ecidium* is not an autonomous genus, but only a stage of development of other Uredineous genera.

The following are the descriptions of the *Ecidia* collected by Dr. Welwitsch :—

No. 105. *Peridiis* stipatis, minime profundis, petiolum tegentibus, et subinde in folia transeuntibus, margine subcrenulato, laciniis brevissimis; *sporis* vivis aurantiacis, siccitate pallidis, subglobosis vel ovato-oblongis, forma et crassitudine variis, 0·0009-0·0012 longis.

Hab. Ad folia *Cissi* spec. prope Caghúy, Pungo Andongo, Novemb. 1856.

No. 128. Hardly differs from No. 105, except in the more scattered peridia and more irregularly shaped spores.

Hab. Ad folia fruticuli e familia Ebenacearum in rupestribus de Morro de Monino, distr. Huilla, rarius obvium, April 1860.

No. 128 *a*. *Peridiis* albis, cylindricis, elongatis, marginis laciniis irregularibus; *sporis* ut in No. 128.

Hab. Ad folia spec. *Euphorbiæ*, in pascuis dumetosis aliquanto petrosis, subsiccis, prope Lopollo, Huilla, Mart. 1860.

No. 127. *Peridiis* sparsis, campanulatis, pallidis; marginis laciniis brevibus et crenulatis; *sporis* ut in 105.

Hab. Rarius ad folia suffruticis Rubiacearum in dumetis prope lacum magnum de Ivantala, distr. Huilla, Feb. 1860.

No. 8 is also a species of *Æcidium*, but it is not describable from dried specimens.

UROMYCES ALLIORUM, DC.

Hab. Ad folia *Liliaceæ asphodeloideæ*, in pratis humidis prope Muta Lucala, Pungo Andongo, Martio 1857. No. 19.

Ad folia et scapos *Albucæ juncifoliæ*, Pungo Andongo, Maio 1857. No. 22.

No. 130 is an effused *Uredo*, covering the underside of the leaves of a Rubiaceous plant. The spores are subglobose or elliptical, echinulate, 0·0011 to 0·0013 long.

DESCRIPTION OF THE PLATES.

PLATE 17.

Figs. 1–4. *Meliola formosa*, Welw. & Curr.: fig. 1, a branch of the mycelium, slightly magnified; fig. 2. setæ, *id.*; fig. 3, spores, × highly; fig. 4, fragments of the mycelium, × 430 diameters.
Figs. 5 & 6. *Xylaria arenicola*, Welw. & Curr., × slightly.
Fig. 7. *Laternea angolensis*, Welw. & Curr., natural size.

Fig. 8. *Lysurus corallocephalus*, Welw. & Curr., natural size.
Figs. 9–11. *Helminthosporium Cordiæ*, Welw. & Curr., filaments and spores, × highly.
Figs. 12 & 13. *Pemphidium nobile*, Welw. & Curr.: fig. 12, *sporidia*, × 420 diameters; fig. 13, a *peri-thecium*, × slightly.
Fig. 14. *Pestalozzia depazeoides*, Welw. & Curr., spores, × highly.
Fig. 15. *Sporidesmium celatum*, Welw. & Curr., spores, × highly.
Figs. 16 & 17. *Phoma confluens*, Welw. & Curr.: fig. 16, *perithecia*, × ; fig. 17, *sporidia*, × highly.
Fig. 18. *Hypoxylon suborbiculare*, Welw. & Curr., vertical section, natural size.
Figs. 19 & 20. *Hypoxylon angolense*, Welw. & Curr.: fig. 19, plants, of the natural size; fig. 20, *sporidia*, × highly.
Fig. 21. *Asterina difformis*, Welw. & Curr., *asci* and *sporidia*, × 420 diameters.
Fig. 22. *Hypoxylon aggregatum*, Welw. & Curr., detached *perithecia*, × .
Fig. 23. Spores of *Podaxon mossamedensis*, Welw. & Curr., × highly.
Figs. 24 & 25. *Xylaria axillaris*, Welw. & Curr.: fig. 24, two plants, × ; fig. 25, *sporidia*, × 420 diameters.

Plate 18.

Figs. 1 & 2. *Sphæriceps lignipes*, Welw. & Curr., plants, of the natural size.
Figs. 3 & 4. *Xylaria aphrodisiaca*, Welw. &. Curr., plants, of the natural size.
Figs. 5 & 6. *Hypoxylon cetrarioides*, Welw. & Curr.: fig. 5, natural size; fig. 6, one of the ramifications, magnified.
Fig. 7. *Xylaria variabilis*, Welw. & Curr., natural size.

Plate 19.

Figs. 1–3. *Podaxon mossamedensis*, Welw. & Curr., natural size: fig. 3 represents a plant with the *peri-dium* removed, showing the *capillitium* adhering to the *stipes*.
Figs. 4, 5 & 6. *Podaxon elatus*, Welw. & Curr.: figs. 4 & 5, plants, of the natural size; fig. 6, a fragment of a thread of the *capillitium*, spirally ruptured.
Figs. 7 & 8. *Lycoperdon tomentosum*, Welw. & Curr., natural size.

Plate 20.

Figs. 1 & 2. *Lycoperdon cæspitosum*, Welw. & Curr., natural size.
Figs. 3 & 4. *Lycoperdon asperrimum*, Welw. & Curr., natural size.
Figs. 5, 6 & 7. *Podaxon loandensis*, Welw. & Curr., natural size.
Figs. 8 & 9. *Lycoperdon radicatum*, Welw. & Curr., natural size.
Figs. 10 & 11. *Tulostoma angolense*, Welw. & Curr., natural size.
Fig. 12. *Lycoperdon bicolor*, Welw. & Curr., natural size.
Fig. 13. *Lycoperdon golungense*, Welw. & Curr., natural size.
Fig. 14. *Lycoperdon asperrimum*, Welw. & Curr., natural size.

VII. *Notes on the* Thysanura.—Part III.

By Sir John Lubbock, *Bart., F.R.S., V.P. Linn. Soc., Pres. Ent. Soc., V.P. Ethn. Soc., &c.*

(Plates XXI. & XXII.)

Read June 6th, 1867.

The following Memoir contains descriptions of seventeen species of *Thysanura*, belonging to the Smynthuridæ, Poduridæ, and Lipuridæ. Five are new; the others have been already observed on the Continent. With those described in my previous Memoirs, and the sixteen in that of Templeton, this will make a total of about fifty species, one-fourth of which have been as yet observed in this country only. I have also met with several forms which will probably prove to be distinct species, but about which I am not as yet prepared to offer a decided opinion. There can, however, be very little doubt that many more species remain to be discovered in this country. Even the Continent has been anything but thoroughly examined; and yet, including the Lepismidæ and the curious genera *Campodea* and *Nicoletia*, 117 species are said to occur in Europe, of which eighty-three have been found in France.

Smynthurus viridis. (Pl. XXI. figs. 1–3.)

Podura viridis, Geoffroy, Ins. d. Env. de Paris, ii. p. 607.
—— ——, Schrank, En. Ins. Austr. p. 495.
—— ——, Fabricius, Entom. Syst. ii. p. 65.
—— ——, Linn. Syst. Nat. i. p. 2907.
Smynthurus viridis, Nicolet, Rech. pour servir à l'histoire des Podurelles, p. 82, Mém. Soc. Helv. vi.
—— ——, Bourlet, Sur les Podurelles, p. 56, Mém. Soc. R. de Douai.
—— ——, Lucas, Hist. Nat. Crust. Arachn. et Myriapod. p. 567.

Green; eyes on a black patch; terminal segments of antennæ reddish; abdomen with a reentering angle; hairs scattered.

Length $\frac{1}{12}$ of an inch. Very common among grass, in May, June, July, August, and September. It is sometimes attacked by a small red mite.

Geoffroy's description of this insect is still quite sufficient: "*P.* viridis, oculis nigris, capite flavescente, antennis in medio fractis."

The antennæ have the basal segments pale green, the terminal one reddish. The segments increase in length from the base to the apex. The basal one is ·004 of an inch in length, and ·003 in breadth; the second is ·008 in length, the third ·013, and the fourth ·027. The segments do not taper, though each is a little narrower than the preceding. The terminal segment has about twenty whorls of hairs. The mandibles are of the usual form; one of them, however, is somewhat characteristic, from having the penultimate tooth unusually projecting. The maxillæ resemble those of *S. Buskii* (Linn. Trans. vol. xxiii. pl. 45. fig. 6). The feet resemble those of *P. cursor*; there are no

tenent hairs. Pl. XXI. fig. 2 represents one of the posterior feet. The spring is simple in form (Pl. XXI. fig. 3). It has no tenent hairs; and the terminal lamellæ are without teeth; the hairs are simple, and shaped like a lady's riding-whip, but rather rough.

Smynthurus luteus, n. sp. (Pl. XXI. figs. 4–7.) Yellow; eyes on a black patch; apical portion of antennæ violet.

The females, which are decidedly larger than the males, are about $\frac{1}{33}$ of an inch in length. Very common, among grass, from May to July.

In colour and in habits this species closely resembles the *S. lupulinæ*, of Bourlet; the eyes, however, are situated on a black patch. My *S. aureus* agrees with *S. luteus* in the possession of the black patch, but differs in the form of the caudal lamellæ, of the feet, and of the antennæ.

The four segments of the antennæ (Pl. XXI. fig. 5) increase in length from the base to the apex, each being nearly twice as long as the preceding: the proportions are 8, 15, 24, 45. The terminal portion consists of about twelve segments more or less closely soldered together and each bearing a whorl of hairs; the four central segments are more distinctly marked than those on either side of them. At the extremity of the organ are some rod-like hairs.

Though the males are smaller than the females, their antennæ are not only relatively, but absolutely longer. In form, however, there is no material difference between the sexes.

The *mandibles* are strong, but the terminal teeth, excepting the last of all, project very slightly. The teeth are four and five in number; those of the male and female are alike.

The *claws* (Pl. XXI. fig. 6) are simple; the inner one is small; there are two tenent hairs on the upperside; and the inner claw, which is elongated, appears to terminate in a small globular expansion, which has probably the same function. The feet are alike in both sexes.

Caudal appendage (Pl. XXI. fig. 7). The basal segment tapers slightly; it bears scattered setæ, but no tenent hairs. The terminal lamellæ are elliptical, without setæ or teeth. At the end of the abdomen are two setæ much stronger than the rest. The caudal appendage of the male resembles that of the female.

Some specimens have on each side two longitudinal bands of rather darker yellow. These, I believe, only form a variety. These specimens have three dark spots in a on each side in the paler portion; each of these bears a hair.

It is very amusing to see these little creatures coquetting together. The male, which is much smaller than the female, runs round her, and they butt one another, standing face to face, and moving backwards and forwards like two playful lambs. Then the female pretends to run away and the male runs after her, with a queer appearance of anger, gets in front and stands facing her again; then she turns coyly round, but he, quicker and more active, scuttles round too, and seems to whip her with his antennæ; then for a bit they stand face to face, play with their antennæ, and seem to be all in all to one another.

SMYNTHURUS BOURLETII, Gervais. (Pl. XXI. figs. 8–10.)

Suites à Buffon, Ins. Aptères, iii. p. 403.

Dark purple and yellow. The purple forms two broad, irregular bands with broken edges running along the side of the body; there are two yellow patches on the head between the black eye-patches, separated by a central band of dark purple, and uniting behind. The spring, legs, and underside of body are yellow, the two terminal segments of the antennæ with a brownish tinge.

I found this pretty little species among long grass at High Elms, in June and July. The antennæ resemble those of *Smynthurus luteus*, but the terminal segment (Pl. XXI. fig. 9) is less distinctly ringed.

The mandibles offer no special peculiarity; they have respectively four and five teeth; the one with four has only the terminal one large, the other three are very small. In the mandible with five teeth they are all well marked, increasing in size from the base to the extremity. The feet have the two claws more equal in size; the tenent hairs are slightly marked.

The spring has only a few scattered hairs (Pl. XXI. fig. 10), none of which are tenent. The terminal segment is knife-shaped, somewhat pointed at the extremity, and very finely serrated on the inner margin.

There is no other species with which this can be confounded.

SMYNTHURUS NIGER, n. sp. (Pl. XXI. figs. 11, 12.) Bluish black; feet, terminal segment of spring, and a spot at the front inner corner of each eye-patch pale. Hairs short, white, more or less in longitudinal rows.

Length $\frac{1}{23}$ of an inch. Under boards in my kitchen-garden. Not common, solitary, August to December.

This ugly little species does not resemble any one yet described. It differs from *S. ater* of De Geer in the form of the spring &c., and from *S. fuliginosus* of Nicolet in the absence of white patches on the body, and in having the head and antennæ black.

The terminal portion of the antenna is not distinctly ringed, the position of the subsegments being, however, indicated by the whorls of hairs. The upper lip is naked and rounded; one mandible has five teeth, while in the other they are rudimentary. The feet have several tenent hairs. The large claw is simple, the smaller one is narrower in the anterior legs than in the posterior ones. The terminal lamellæ of the saltatory appendage (Pl .XXI. fig. 12) are narrow and pointed. Both appear to have on the same side a row of fine teeth; in fact there are two rows on the under surface, which, being almost always thrown either to one side or the other, give the appearance of asymmetry.

SMYNTHURUS PALLIPES, Bourlet. (Pl. XXI. figs. 13–15.)

Smynthurus pallipes, Bourlet, Sur les Podurelles, p. 59.

—— ——, Gervais, Suites à Buffon, Aptères, p. 404.

—— ——, Nicolet, Ann. Soc. Ent. France, 2e sér. v. p. 359.

Purple; antennæ, legs, and hairs pale yellow; eyes on a black patch; spring white.

Abdomen with a reentering angle and scattered pale hairs.

High Elms, among grass. Common, May to July.

Length $\frac{1}{28}$ of an inch.

One mandible has five well-marked teeth; the other can hardly be said to have any at all.

The feet much resemble those of *S. luteus*; there are two tenent hairs above, and one on the underside. The larger claw is simple, the lesser one very small.

The saltatory appendage (Pl. XXI. fig. 15) also much resembles that of *S. luteus*.

ORCHESELLA CINCTA, L.

Podura cincta, Linn. Syst. Nat. ii. p. 1014.
—— *vaga*, Linn. ibid. p. 1013.
—— ——, Fab. Ent. Syst. ii. p. 66.
—— *cincta*, Fab. ibid. p. 67.
Orchesella filicornis, Templeton, Tr. Ent. Soc. i. p. 93.
—— *cincta*, Templeton, ibid. p. 93.
Heterotoma vaga, Bourlet, Sur les Podurelles, Mém. Soc. R. d. Lille, 1839, p. 398.
—— *cincta*, Bourlet, Sur les Podurelles, ibid. p. 399.
Ætheoscerus pulchricornis, Bourlet, Sur les Podurelles, Mém. Soc. R. d. Douai, p. 22.
—— *cinctus*, Bourlet, ibid. p. 23.
Orchesella fastuosa, Nicolet, Sur les Podurelles, Mém. Soc. Helv. vi. p. 78.
—— ——, Gervais, Aptères, iii. p. 414.
—— *filicornis*, Gervais, ibid. p. 415.
—— *cincta*, Gervais, ibid. p. 421.

This common and pretty species varies very much in colour, and has been described by different authors under a variety of names. In addition to the synonyms given above, I have little doubt that some of the other supposed species of *Orchesella* will eventually prove to be only the young of this.

The third abdominal segment and the third segment of the antennæ are black; the apical half of the second segment of the antennæ, the posterior half of the second abdominal segment, two patches on the mesothorax, and two spots on the posterior margin of the fourth abdominal segment are white; the two terminal segments of the antennæ are brown; the rest of the body is mottled, and in different specimens may be found of every hue between light reddish brown and deep black.

Of course, in the black specimens the dark band on the third abdominal segment ceases to be conspicuous, and the pale one on the second abdominal segment comes out by contrast; such specimens constitute the *Podura vaga* of Linnæus and subsequent authors. On the other hand, in pale specimens the dark band on the third abdominal segment is the salient feature; and these specimens form Linnæus's *P. cincta*. This name seems to me the best of all those which have been given to the species, because in all cases the transverse abdominal band is the distinctive characteristic of the species.

DEGEERIA LANUGINOSA, Nicolet. (Pl. XXII. figs. 16–18.)

Degeeria lanuginosa, Nicolet, Podurelles, p. 74.
—— ——, Gervais, Aptères, p. 425.

Fusiform; entirely grey, with a tinge of green; antennæ, legs, andsaltatory appendage somewhat paler than the rest of the body, which is very hairy. The upper surface is thickly covered with clubbed hairs. Eyes black. Sixth segment of the body as long as the three or four preceding taken together.

Length $\frac{1}{20}$ of an inch.

Under pieces of wood in winter; not common.

The second and third segments of the antennæ are about equal in length, and somewhat shorter than the apical. The feet have a single tenent hair.

Degeeria nicoletii, n. sp. (Pl. XXII. fig. 19.) Yellow; eyes on a black patch; terminal portion of antennæ tinted with violet; a reddish-brown band between the eyes; two brown patches on the posterior end of the fourth abdominal segment, and a band of the same colour on the posterior margin of the seventh.

Length about $\frac{1}{15}$ of an inch.

Common on bark and among grass in spring and summer.

The antennæ are about three-fifths of the length of the body. The basal segment is rather shorter, and the apical rather longer, than the two middle ones, which are of about the same length. Besides the short hairs pointing forwards, the three basal segments have a few rather longer ones, which stand out at right angles to the segment itself.

The brown band on the head between the eyes also projects a little behind them.

The mandibles have respectively three and five rather blunt teeth.

The body is somewhat thickly clothed with hairs, which are of three sorts:—first, the ordinary short hairs, which are spread pretty evenly over the whole surface, as well as over the appendages; secondly, longer clubbed hairs, as in Pl. XXII. fig. 17; these generally stand at right angles to the skin, and are characteristic of *Degeeria* and *Orchesella*; they occur only on the body; thirdly, long, serrated hairs, most of which lie along the body, but some of those at the posterior extremity, as well as a few scattered ones on the legs, stand out at right angles. Lastly, there are on the fourth abdominal segment a few still longer, serrated hairs which have a curious bend in the middle, as in Pl. XXII. fig. 18; this bend is not accidental, as might at first be supposed, but is always present.

The feet have two claws and one tenent hair; they are all six alike, and resemble those of *D. nigromaculata* or *Lepidocyrtus argentatus* (see Linn. Trans. xxiii. pl. 59. fig. 17).

Isotoma trifasciata, Bourlet. (Pl. XXII. figs. 20, 21.)

Isotoma trifasciata, Bourlet, Mém. sur les Podurelles.

—— *bifasciata*, Bourlet, ibid.

—— ——, Nicolet, Ann. Soc. Ent. de France, 2e sér. v. p. 374.

Greenish yellow, mottled with purplish-brown patches, which form three more or less wide and continuous bands down the back. Underside of body, antennæ, legs, and caudal appendage pale. Eyes on a black patch. Basal segment of the antennæ rather shorter than the other three, which are subequal.

In damp situations, under fallen branches of trees, and among decaying leaves, throughout the year; common.

Length $\frac{1}{10}$ of an inch.

Many specimens are pale, irregularly mottled with purplish-brown patches. In dark specimens, however, the purplish-brown colour usually occupies the greater part of the back, and the yellowish-green portion is thus reduced to two more or less irregular bands, which, however, increase in size towards the posterior extremity of the body. These specimens appear to me to form the type of Bourlet's *I. bifasciata*. He describes the antennæ, however, as "annelés de brun à leur sommet." On the other hand, in pale specimens the dark areas are reduced, and, as the underside is pale, the dark portion thus comes to form three bands, one in the centre of the back, and one on each side. These specimens, I think, constitute Bourlet's *I. trifasciata*, which is characterized by having three dark longitudinal bands on a greenish ground. I prefer this latter name as being the most characteristic.

This species is rather broader in proportion to its length than most of the others. The head is shaped like a capital D, and, like the whole body, is clothed with short hairs, many of which, on the head and thorax, are slightly longer than those of the abdomen. On the other hand, the posterior abdominal segments possess a few long setæ, which point backwards.

The caudal appendage extends forwards beyond the base of the so-called gastric tube. It is sometimes quite pale, sometimes yellowish, almost approaching to orange in colour.

The antennæ are four-jointed, and clothed with short hairs. The basal segment measures about $\frac{1}{100}$ of an inch in length; the second and third segments are equal, and measure $\frac{15}{800}$ each, while the terminal segment is somewhat longer, and reaches $\frac{18}{800}$ in length.

The mandibles have respectively four and five teeth, and offer no special peculiarities.

The legs are of moderate length, the posterior ones being, as usual, the longest, owing almost entirely to the elongation of the femur and tibia. The whole leg is clothed with the usual small hairs, mixed with a few larger ones; there are no tenent hairs.

The feet (Pl. XXII. fig. 21) of all the three pairs of legs are alike. The large claw is simple and stout; the second appendage is of irregular shape; on the side which is turned towards the large claw it projects considerably, and bears a small tooth. The end is produced into a very fine thread-like point.

LEPIDOCYRTUS ÆNEUS, Nicolet.

Cyphodeirus æneus, Nicolet, Podurelles, p. 66.

Brazen metallic; first and third segments of antennæ short. Eyes black. Antennæ yellow at base, the rest brown. Hairs few; the usual thick bunch on first body-segment. Thorax gibbous, but not projecting. Head set on almost straight. Body broadest in front, not ovate.

I found one specimen in December.

This species is compressed laterally, which, together with its colour and its power of

jumping, give it very much the appearance of a flea. I have referred it to Nicolet's *C. æneus*, though with some doubt, as the antennæ do not altogether agree with his description.

LEPIDOCYRTUS GIBBULUS, Nicolet. (Pl. XXII. fig. 22.)

Cyphodeirus gibbulus, Nicolet, Podurelles, p. 64.

Nicolet's description of this species is as follows:—

"Semblable au précédent (*L. capucinus*) pour la couleur, mais plus court et proportionnellement plus large. Premier article des antennes jaune, les suivants d'un gris foncé légèrement violacé. Premier segment du corps, très-convexe, peu prolongé en avant et cilié au bord antérieur. Deuxième segment, un peu plus long que le suivant. Bord inférieur du sixième segment rougeâtre. Filets de la queue courts et blancs. Pièce basilaire de la couleur du corps. Yeux noirs. Corps luisant, très-peu velu. Même reflet métallique que le précédent."

Length $\frac{1}{25}$ of an inch. Among moss and in gardens. Rather rare, solitary.

High Elms. I found a few specimens in winter, under logs of wood.

LEPIDOCYRTUS ALBINOS, Nicolet.

Lepidocyrtus albinos, Nicolet, Podurelles, p. 67.
—— ——, Gervais, Aptères, iii. p. 412.

Oblong, white; the first and third segments of the antennæ short and conical: body very brilliant and without many hairs.

Length $\frac{1}{25}$ of an inch.

Under decaying boughs and in similar places.

PODURA AQUATICA, De Geer.

Podura aquatica, De Geer, vii. p. 14.
—— ——, Linnæus, Sys. Nat. 1814.
—— ——, Fabricius, Ent. Sys. ii. p. 67.
—— *atra aquatica*, Geoffroy, Ins. Env. Paris, ii. p. 610.
—— —— ——, Boisd. et Lacord. Faun. Ent. Env. Paris, i. p. 114.
—— —— ——, Lucas, Hist. Nat. Anim. Art. p. 565.
Hypogastrura aquatica, Bourlet, Podurelles, p. 35.
Podura aquatica, Nicolet, Podurelles, p. 55.
—— ——, Nicolet, Ann. Soc. Ent. France, 2e sér. v. p. 375.

I found a few specimens of this species on a pond at Chiselhurst, in Kent, during the summer of 1863.

ACHORUTES ARMATUS, Nicolet. (Pl. XXII. fig. 23.)

Podura armata, Nicolet, Podurelles, p. 57.
Hypogastrura fuscoviridis?, Bourlet, Podurelles, p. 37.
Achorutes armatus, Gervais, Aptères, iii. p. 437.

Nicolet's description of this species is as follows:—

"D'un gris verdâtre sur la tête et le dos; dessous du corps, antennes et pattes gris pâle. Une tache triangulaire d'un brun sombre entre les yeux, et quelques autres taches de même couleur sur le reste de la tête. Yeux noirs. Deux lignes longitudinales et parallèles de taches à peu près triangulaires et également brunes, sur le dos. Poils gris. Appendice saltatoire très-court. Deux crochets recourbés en dessus à l'extrémité de l'abdomen, au-dessus de l'anus.

"Longueur 1 millim. et demi.

"Sur les eaux stagnantes; peu commune."

I have several times found specimens on a hotbed in autumn which agreed pretty well with Nicolet's description and figure; the spots, however, were scarcely apparent.

The caudal appendage of my specimens is figured in Pl. XXII. fig. 23.

Achorutes purpurescens, n. sp. (Pl. XXII. figs. 24–26.) Brownish purple, underside of body rather paler. Eyes not on a black patch. Body covered with short, scattered, white hairs; two clawed hooks at the posterior extremity of the body.

Length $\frac{1}{12}$ of an inch.

On a hotbed and under branches of trees, throughout the year.

I was at first disposed to refer this species to the *A. armatus* of Nicolet. It differs, however, in the colour of the body, and in the absence of brown spots on the back. Moreover, if I have been right in identifying the preceding species with the *A. armatus* (*Podura armata*) of Nicolet, it differs from the present in having larger abdominal hooks, and in the form of the caudal appendage, as may at once be seen by comparing Pl. XXII. fig. 23, which represents the caudal appendage of *A. armata*, with fig. 26 of the same plate, in which I have figured the corresponding organ of *A. purpurescens*. Again, in the present species the eye is not on a black patch.

The antennæ are short, and composed of four segments; the articulations are somewhat oblique; and the two terminal segments form a sort of club. The mandibles have respectively four and five teeth. The skin of the body, as well as of the appendages, is granular, and covered with short, scattered, smooth, white hairs.

The anterior feet (Pl. XXII. fig. 25) have two long tenent hairs, which, however, are but little swollen at the extremity. The large claw bears a single tooth on the underside; the small claw is of somewhat peculiar form, and terminates in a filament. The second and third pair of feet differ from the first principally in having three tenent hairs, which, moreover, seemed to me to be more enlarged at the tip than those of the anterior feet.

The caudal appendage is simple and two-jointed, as in Pl. XXII. fig. 26.

Achorutes murorum, Bourlet.

Achorutes murorum, Bourlet, Podurelles, p. 35.

I have occasionally found, during winter, a small very dark species of *Achorutes*, which I have referred with a good deal of doubt to the *A. murorum* of Bourlet. It is of a bluish black, and, as usual, is paler below. The eyes are on a black patch. It has very minute abdominal hooks, and the feet have a single tenent hair. The skin is granulated.

ACHORUTES RUFESCENS, Linnæus.

Podura rufescens, Linnæus, Sys. Nat. Gmelin's ed. p. 2910.
Achorutes rufescens, Nicolet, Podurelles, p. 57.

Brick-red; eyes on a black patch; abdominal hooks very minute.
Common in winter among dead leaves.

LIPURA FIMETARIA, L. (Pl. XXII. figs. 27, 28.)

Podura fimetaria, Linnæus, i. p. 2909.
—— ——, Schrank, En. Ins. Aus. p. 497.
—— ——, Fabricius, Ent. Syst. p. 67.
—— ——, Lucas, Hist. Nat. Crust. Arachn. et Myriapod. p. 565.
Lipura fimetaria, Burmeister, Handb. der Ent. xi. p. 447.
Anurophorus fimetarius, Nicolet, Mem. Soc. Helv. 1839.
Adicranus , Bourlet, Mém. Soc. Roy. Douai, 1842.
—— *volvator*, Gervais, Suites à Buffon, Aptères, iii. p. 442.
—— *fimetarius*, Nicolet, Ann. Soc. Ent. France, 2e sér. v. p. 385.

White; skin granular; prothorax short, but not covered by mesothorax; posterior extremity of abdomen without hooks.

Length $\frac{1}{10}$ of an inch.

In damp places, under boards, flowerpots, &c. Common, sociable.

The antennæ are shorter than the head; they are four-jointed and somewhat clubbed. The articulations between the second and third, and third and fourth segments are oblique. The organ is covered with short, stiff hairs, which are most numerous on the apical segment.

The mandibles have four teeth each; in one of them the penultimate tooth projects beyond the others.

The body is thinly clothed with short scattered hairs. The legs are short. The large claw is big and simple; the smaller one resembles a seta, but is thickened at the base. There are no tenent hairs.

This species has frequently been confounded with *L. ambulans*, which, indeed, it very much resembles. They may, however, be at once distinguished by the posterior end of the abdomen, which in *L. ambulans* is armed with two small upright hooks; these are entirely absent in the present species. According to Nicolet, there is also a considerable difference in the eyes. In *L. ambulans* these are fourteen in number on each side, arranged in two parallel lines running obliquely across the head immediately behind the antennæ. *L. fimetaria*, on the contrary, has only eight eyes on each side, which form an oblong group. They are, however, in both species very difficult to make out.

As Nicolet has himself pointed out, his *Anurophorus fimetarius* (Podurelles, p. 53) is really the *P. ambulans* of Linnæus.

From *L. corticina* and *L. laricis*, which are probably identical, *L. fimetaria* is at once distinguished by the colour.

One of my specimens laid some eggs on the 8th September; they were fifteen in number, spherical, white, and $\frac{1}{180}$ of an inch in diameter.

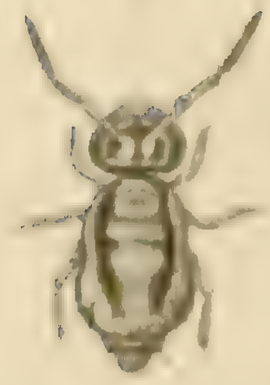
DESCRIPTION OF THE PLATES.

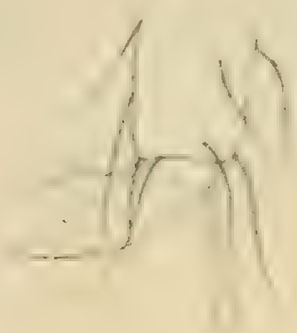
Plate XXI.

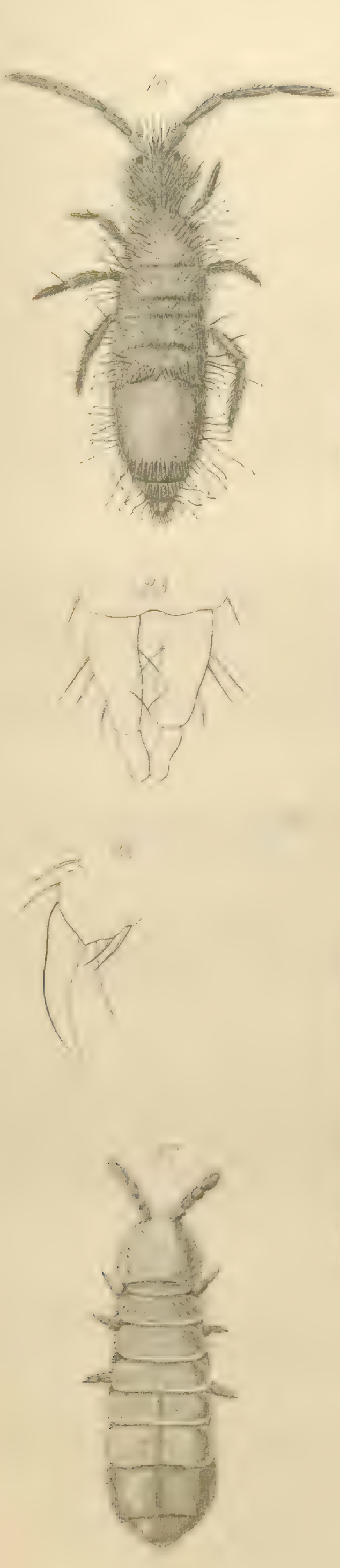
Fig. 1. *Smynthurus viridis*, × 30.
Fig. 2. „ „ Anterior foot, × 250.
Fig. 3. „ „ Saltatory appendage, × 30.
Fig. 4. „ *luteus*, × 30.
Fig. 5. „ „ Antenna of female, × 125.
Fig. 6. „ „ Foot, × 250.
Fig. 7. „ „ Saltatory appendage, × 125.
Fig. 8. „ *Bourletii*, × 30.
Fig. 9. „ „ Antenna, × 125.
Fig. 10. „ „ Saltatory appendage, × 125.
Fig. 11. „ *niger*, × 30.
Fig. 12. „ „ Saltatory appendage, × 125.
Fig. 13. „ *pallipes*, × 30.
Fig. 14. „ „ Antenna, × 125.
Fig. 15. „ „ Saltatory appendage, × 125.

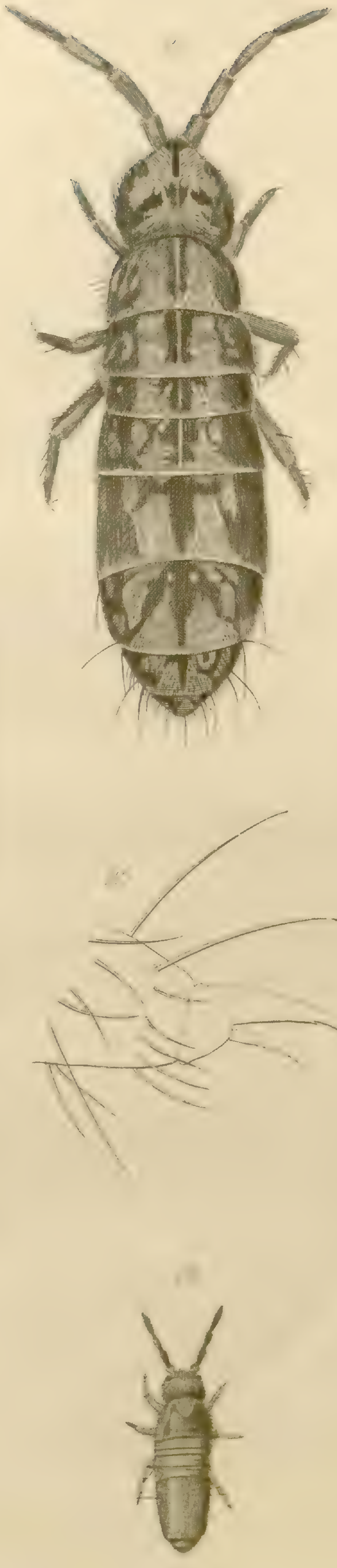
Plate XXII.

Fig. 16. *Degeeria lanuginosa*, × 30.
Fig. 17. „ „ Clubbed hair, × 250.
Fig. 18. „ „ Bow-shaped hair, × 250.
Fig. 19. „ *Nicoletii*, × 30.
Fig. 20. *Isotoma trifasciata*, × 30.
Fig. 21. „ „ Foot of anterior leg, × 250.
Fig. 22. *Lepidocyrtus gibbulus*, × 30.
Fig. 23. *Achorutes armatus*. Saltatory appendage, × 125.
Fig. 24. „ *purpurescens*.
Fig. 25. „ „ Anterior foot, × 125.
Fig. 26. „ „ Saltatory appendage, × 125.
Fig. 27. *Lipura fimetaria*.
Fig. 28. „ „ Posterior foot, × 125.









J. Lubbock & A.T. Hollick del.

G. Jarman sc.

VIII. *On the Geographical Distribution of Ferns.* *By* J. G. Baker, *Esq.*, *F.L.S.*

Read April 4th, 1867.

THERE is no extensive natural Order with the distribution of which we are nearly so well acquainted as we are with that of the Ferns. Their beauty and the popularity which they have enjoyed for the last twenty years has been such that all travellers in distant countries who have collected plants at all have paid a full share of attention to Ferns amongst the rest, and that many have neglected flowering plants altogether to concentrate their attention upon Ferns alone. The consequence is, that we now know so much about the distribution of the Order in the various parts of the world, that it is not likely that further discovery will modify materially our ideas of its general outlines. I do not know that any definite attempt has been made to reduce into systematic order the great body of information upon the subject which has been gradually accumulated; but, in the interests of that department of inquiry for which we still want one general comprehensive name (the study of the facts of the distribution of organized beings over the surface of the globe, and the laws which regulate those facts), it seems very desirable that such a classification should be attempted, especially for this reason, that if anywhere we may hope to find a large Order with distinctly marked and clearly definable climatic relations, it is here. Without a single prominent exception, we find that the whole Order, of between two and three thousand clearly marked species, requires shade and a damp atmosphere, that everywhere within the tropics there are no Ferns at all (or very few) in the dry countries and provinces, that, with the precision of an hygrometer, an increase in the fern-vegetation (it may be in species, or it may be in the number and luxuriance of individuals, but usually in both) marks the wooded humid regions, and that, receding from the tropics, although with latitude the species diminish in number, there is the same contrast between the two categories of climate—the dry continental type with a large, and the damp insular type with a small hiberno-æstival range. My aim, therefore, in the present paper is to bring together the leading facts of fern-dispersion in a form available for comparison and reference.

In the accompanying Table the 'Synopsis Filicum' (now in the press, planned and commenced by Sir William Hooker, which I have had the honour of being entrusted to carry on, and the material for which is now all prepared) has been followed implicitly for nomenclature and species-limitation. As has been already explained in the preface, we have included only the species respecting which we possess definite information, and have wished and intended to retain as species only such as are clearly separable. The application of this last test, employed as it has been with the help of an herbarium of fifty thousand specimens, a large proportion of them furnished or named by the leading writers on the subject, and a collection of the plates of Ferns which have been published which is complete for all practical purposes, has been to reduce the number of

recorded species to an extent which no one who has not made Ferns a special study is likely to anticipate. The great difficulty in botanical geography in comparing lists of species of one group or of one country with those of others is, that species are limited by different authors upon such widely different principles. The extent of this divergence amongst Ferns will be shown most clearly by a few figures. Where De Vriese has 94 Marattiaceæ, we have only been able to define 9; where Van den Bosch has 450 Hymenophyllaceæ, we have 149; where Presl has 21 species of *Osmunda*, we have 5; where Fée has 17 species of *Lomariopsis*, we can only define 1; where Sturm has 12 Brazilian species of *Lygodium*, we have only 2. The total number of species, in the Synopsis-sense of the term, which we have been able to make out is a little over 2200; but I am certainly within the mark in saying that if all the tribes were uniformly worked out upon the plan followed by all or any of the authors whose names have been quoted, we should have five or six thousand. All experience goes to show that if for botanico-geographical purposes we do not confine our numerical comparisons to well-marked species, we soon become entangled in a maze of confusion. The number of species which we have been able clearly to make out and define, of which there are not specimens in the Kew collection, is very small; and in the same way, in the following Table II. and the remarks founded upon it, in very few cases are they registered for districts without specimens having been actually examined. The districts adopted are as follows, viz.:—

1. The Arctic zone all round the world.

2. The rest of Europe and the extra-tropical part of Northern Africa, including the extra-tropical western islands. Species peculiar to these latter are marked C.

3. Temperate Asia. All the species in the third column marked with the figure 3 inhabit the temperate region of the Himalayas; but those marked S are confined to the subtropical zone on the southern flank of the Himalayan range. The few species peculiar to Western Asia are marked W; those peculiar to the rest of the continent outside the Himalayas are marked C, and those peculiar to Japan are marked J.

4. Temperate North America, not including any part of Mexico.

5. Extra-tropical South Africa, including the island of Tristan d'Acunha, the species peculiar to which, so far as this district is concerned, are marked T.

6. New Zealand, Van Diemen's Land, and temperate Australia, including the small south temperate islands. Species peculiar to the latter are marked N; those peculiar to Australia, with Van Diemen's Land, A; and those peculiar to New Zealand, Z.

7. Temperate South America.

8. Tropical Africa. Species peculiar to the eastern group of islands (Madagascar, Mauritius, Bourbon, and the Comoro Isles) marked M; to the Seychelles, marked S; to to the east side of the continent, marked E; to the west side of the continent, marked W; to St. Helena, H; and to Ascension Island, A.

9. Tropical Asia, including the Malayan and tropical Polynesian islands. Species peculiar to the latter, marked M and P respectively, and species peculiar to Ceylon and peninsular Hindostan, marked H. Formosa, Hong Kong, tropical China, and the Philippines, and the Malay peninsula, are included under M. Species peculiar to Tropical Australia marked A.

10. Tropical America, including the whole of Mexico and Brazil. Species peculiar to the West-Indian Islands, marked I, should be under 9.

Table I. is intended to show roughly the area of the districts thus obtained, to which is added the temperature of a few selected stations at the sea-level.

TABLE I.

District.	Approximate area in millions of sq. miles.	Stations.	Temperature.		
			January.	July.	Difference.
			°	°	°
1. Arctic	3	Torneo, Lapland	5	59	54
		Siberia, 140°–130° East long.	−40	55	95
		East coast of Greenland	5	37	32
2. Temperate Europe and Africa	6	England	32–41	59–63	22–27
		Central Europe	23–32	63–72	40
		Moscow	14	65	51
		Barbary States	50–59	77–90	27–31
3. Temperate Asia	14	West Siberia	−5	59	64
		Pekin	26	77	51
		Palestine	50–59	80–85	26–30
4. Temperate North America	5½	Montreal	18	70	52
		Baltimore	32	73	41
		Fort Vancouver	34	65	31
5. Temperate South Africa	¾	Natal	77	70	7
		Cape Town	75	59	16
6. Temperate Australia and N. Zealand	2½	Sydney	70	50	20
		Van Diemen's Land	59	42	17
		New Zealand, north island	59	45	14
		,, south island	55	41	14
7. Temperate South America	1¾	Valparaiso	68	54	14
		Buenos Ayres	72	55	17
		Cape Horn	42	34	8
8. Tropical Africa	10	Nubia	68	90	22
		Gold Coast	79	77	2
9. Tropical Asia and Polynesia	5½	Ceylon	77	81	4
		Mocha	77	90	13
10. Tropical America	6	Jamaica	77	81	4
		Amazon Valley	79	77	2

Table II. is a complete enumeration of species, with the districts in which they occur indicated:—

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
Suborder I. GLEICHENIACEÆ.										
1. Platyzoma microphyllum, *R. Br.*	..	A	..	..	A					
2. Gleichenia moniliformis, *Moore*	..	P								
3. —— polypodioides, *Sm.*	..	..	W	..	..	5				
4. —— circinata, *Sw.*	..	9	..	..	6					
5. —— rupestris, *R. Br.*	..	..	..	..	A					
6. —— Boryi, *Kunze*	..	..	M							
7. —— dicarpa, *R. Br.*	..	9	..	..	6					
8. —— longissima, *Blume*	..	9	..	..	..	..	..	3		
9. —— Bancroftii, *Hook.*	10									
10. —— flabellata, *R. Br.*	..	P	..	..	6					
11. —— tenera, *R. Br.*	..	..	..	..	A					
12. —— Cunninghami, *Hew.*	..	..	..	..	Z					
13. —— umbraculifera, *Moore*	..	..	..	..	..	5				
14. —— pedalis, *Kaulf.*	..	..	..	7						
15. —— cryptocarpa, *Hook.*	..	..	..	7						
16. —— quadripartita, *Hook.*	..	..	..	7						
17. —— revoluta, *H., B. & K.*	10									
18. —— simplex, *Hook.*	10									
19. —— pubescens, *H., B. & K.*	10									
20. —— owhyhensis, *Hook.*	..	P								
21. —— flagellaris, *Spr.*	..	9	M							
22. —— hirta, *Blume*	..	M								
23. —— vestita, *Blume*	..	M								
24. —— pectinata, *Presl*	10									
25. —— dichotoma, *Willd.*	10	9	8	..	6	..	..	3		
Suborder II. POLYPODIACEÆ.										
Tribe 1. Cyatheæ.										
26. Thyrsopteris elegans, *Kunze*	..	..	..	7						
27. Cyathea sinuata, *Hook. & Gr.*	..	H								
28. —— Brunonis, *Wall.*	..	M								
29. —— Hookeri, *Thwaites*	..	H								
30. —— arborea, *Smith*	10									
31. —— serra, *Willd.*	10									
32. —— insignis, *Eaton*	10									
33. —— Imrayana, *Hook.*	10									
34. —— balanocarpa, *Eaton*	I									
35. —— cuspidata, *Kunze*	10									
36. —— divergens, *Kunze*	10									
37. —— gracilis, *Griseb.*	I									
38. —— Mettenii, *Karst.*	10									
39. —— squamipes, *Karst.*	10									
40. —— incana, *Karst.*	10									
41. —— frondosa, *Karst.*	10									
42. —— equestris, *Kunze*	10									
43. —— Beyrichiana, *Presl*	10									
44. —— vestita, *Mart.*	10									
45. —— hirtula, *Mart.*	10									
46. —— Schanschin, *Mart.*	10									
47. —— Sprucei, *Hook.*	10									
48. —— mexicana, *Schlecht.*	10									
49. —— Gardneri, *Hook.*	10									
50. —— ebenina, *Karst.*	10									
51. —— microphylla, *Mett.*	10									
52. —— Dregei, *Kunze*	..	..	E	..	..	5				
53. —— Manniana, *Hook.*	..	..	W							
54. —— Welwitschii, *Hook.*	..	..	W							
55. —— Camerooniana, *Hook.*	..	..	W							
56. —— Angolensis, *Welw.*	..	..	W							
57. —— Kirkii, *Hook.*	..	..	M							
58. —— Sechellarum, *Mett.*	..	..	S							
59. —— excelsa, *Sw.*	..	..	M							
60. —— canaliculata, *Willd.*	..	..	M							
61. —— spinulosa, *Wall.*	..	H	..	..	..	..	..	3		
62. —— crenulata, *Blume*	..	M								
63. —— javanica, *Blume*	..	M								
64. —— integra, *J. Sm.*	..	M								
65. —— Sarawakensis, *Hook.*	..	M								
66. —— assimilis, *Hook.*	..	M								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
67. Cyathea Lobbiana, *Hook.*	..	M								
68. —— hymenodes, *Mett.*	..	M								
69. —— orientalis, *Moore*	..	M								
70. —— arachnoidea, *Hook.*	..	M								
71. —— Korthalsii, *Mett.*	..	M								
72. —— Lindsayana, *Hook.*	..	..	..	..	A					
73. —— medullaris, *Sw.*	..	P	..	..	6					
74. —— Cunninghami, *Hook. fil.*	..	..	..	..	Z					
75. —— dealbata, *Sw.*	..	M	..	..	Z					
76. —— Aneitense, *Hook.*	..	P								
77. —— nigricans, *Mett.*	..	P								
78. —— leucolepis, *Mett.*	..	P								
79. —— Milnei, *Hook.*	..	..	..	..	N					
80. —— affinis, *Sw.*	..	P	..	..	N					
81. —— Vieillardii, *Mett.*	..	P								
82. Hemitelia Karsteniana, *Kl.*	10									
83. —— subincisa, *Kunze*	10									
84. —— grandifolia, *Spr.*	10									
85. —— horrida, *R. Br.*	10									
86. —— petiolata, *Hook.*	10									
87. —— speciosa, *Hook.*	10									
88. —— Lindeni, *Hook.*	10									
89. —— bella, *Reich.*	10									
90. —— apiculata, *Hook.*	10									
91. —— capensis, *R. Br.*	10	M	..	..	..	6				
92. —— platylepis, *Hook.*	10									
93. —— calolepis, *Hook.*										
94. —— Wilsoni, *Hook.*	I									
95. —— Moricandiana, *Kunze*	10									
96. —— Guianensis, *Hook.*	10									
97. —— Walkeræ, *Hook.*	..	H								
98. —— denticulata, *Hook.*	..	P								
99. —— Smithii, *Hook.*	..	..	..	..	Z					
100. —— Junghuhniana, *Mett.*	..	M	M							
101. Alsophila blechnoides, *Hook.*	10									
102. —— phegopteroides, *Hook.*	10									
103. —— Tænitis, *Hook.*	10									
104. —— elegans, *Mart.*	10									
105. —— marginalis, *Klotzsch*	10									
106. —— paleolata, *Mart.*	10									
107. —— Miersii, *Hook.*	10									
108. —— procera, *Kaulf.*	10									
109. —— Schiediana, *Presl*	10									
110. —— armata, *Presl*	10									
111. —— Gardneri, *Hook.*	10									
112. —— aspera, *R. Br.*	10									
113. —— ferox, *Presl*	10									
114. —— leucolepis, *Mart.*	10									
115. —— infesta, *Kunze*	10									
116. —— elongata, *Hook.*	10									
117. —— Pœppigii, *Hook.*	10									
118. —— villosa, *Presl*	10	..	..	7						
119. —— plagiopteris, *Mart.*	10									
120. —— hirta, *Kaulf.*	10									
121. —— nigra, *Mart.*	10									
122. —— radens, *Kaulf.*	10									
123. —— pycnocarpa, *Kunze*	10									
124. —— microphylla, *Kl.*	10									
125. —— Salvinii, *Hook.*	10									
126. —— Godmani, *Hook.*	10									
127. —— sagittifolia, *Hook.*	10									
128. —— melanopus, *Hook.*	10									
129. —— Chimborazensis, *Hook.*	10									
130. —— conjugata, *Spruce*	10									
131. —— Sprucei, *Hook.*	10									
132. —— aterrima, *Hook.*	10			7						
133. —— pruinata, *Kaulf.*	10	..	..							
134. —— frigida, *Karst.*	10									
135. —— Mexicana, *Mart.*	10									
136. —— myosuroides, *Liebm.*	10									
137. —— Samoensis, *Brack.*	..	P								
138. —— decurrens, *Hook.*	..	P								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
139. Alsophila truncata, *Brack.*	..	P								
140. —— Novæ-Caledoniæ, *Mett.*	..	P								
141. —— Tahitensis, *Brack.*	..	P								
142. —— Leichhardtiana, *Muell.*	..	..	..	..	A					
143. —— australis, *R. Br.*	..	P	..	..	A					
144. —— Colensoi, *Hook. fil.*	..	..	..	..	1					
145. —— excelsa, *R. Br.*	..	..	..	..	A					
146. —— lunulata, *Brack.*	..	P	..	..	..	..	..	J		
147. —— alternans, *Hook.*	..	M								
148. —— Celebica, *Mett.*	..	M								
149. —— comosa, *Hook.*	..	M	..	..	..	..	..	S	S	
150. —— contaminans, *Wall.*	..	M	..	..	..	..	..			
151. —— Rebeccæ, *Muell.*	..	..	..	..	A					
152. —— Robertsiana, *Muell.*	..	..	..	..	A					
153. —— crinita, *Hook.*	..	9								
154. —— tomentosa, *Hook.*	..	M								
155. —— caudata, *J. Sm.*	..	M								
156. —— ramispina, *Hook.*	..	M								
157. —— podophylla, *Hook.*	..	M	..	..	..	..	..	C		
158. —— squamulata, *J. Sm.*	..	M								
159. —— glabra, *Hook.*	..	9	..	..	..	..	..	3		
160. —— latebrosa, *Hook.*	..	9	..	..	..	..	..	S		
161. —— lurida, *Hook.*	..	M								
162. —— crenulata, *Mett.*	..	M								
163. —— tristis, *Blume*	..	M								
164. —— subglandulosa, *Hance*	..	M								
165. —— æthiopica, *Welw.*	..	..	W							
166. —— obtusiloba, *Hook.*	..	..	W							
167. Diacalpe aspidioides, *Blume*	..	9	..	..	..	..	..	3		
168. Matonia pectinata, *R. Br.*	..	M								
Tribe 2. DICKSONIEÆ.										
169. Onoclea sensibilis, *L.*	..	..	..	..	..	..	4	CJ		
170. —— germanica, *Willd.*	..	..	..	..	..	..	4	C	2	
171. —— orientalis, *Hook.*	..	..	..	..	..	..	..	3		
172. Hypoderris Brownii, *J. Sm.*	I									
173. Woodsia Ilvensis, *R. Br.*	..	..	..	..	..	..	4	3	2	1
174. —— hyperborea, *R. Br.*	..	..	..	..	..	..	4	3	2	1
175. —— glabella, *R. Br.*	..	..	..	..	..	..	4	3	2	1
176. —— lanosa, *Hook.*	..	..	..	..	..	..	..	3		
177. —— mollis, *J. Sm.*	10									
178. —— Guatemalensis, *Hook.*	10									
179. —— caucasica, *J. Sm.*	..	..	..	..	..	..	..	W		
180. —— elongata, *Hook.*	..	..	..	..	..	..	..	3		
181. —— polystichoides, *Eaton*	..	..	..	..	..	..	..	CJ		
182. —— manchuriensis, *Hook.*	..	..	..	..	..	..	..	C		
183. —— Burgessiana, *Ger.*	..	..	..	..	..	5				
184. —— obtusa, *Hook.*	10	..	..	..	..	..	4			
185. —— Oregana, *Eaton*	..	..	..	..	..	..	4			
186. —— scopulina, *Eaton*	..	..	..	..	..	..	4			
187. —— incisa, *Gillies*	..	..	..	7						
188. —— Peruviana, *Hook.*	10									
189. Sphæropteris barbata, *Wall.*	..	H	..	..	..	..	..	3		
190. Dicksonia glauca, *Smith*	..	P								
191. —— Barometz, *Link*	..	9	..	..	..	..	..	S		
192. —— Menziesii, *Hook. & B.*	..	P								
193. —— Chamissoi, *Hook. & B.*	..	P								
194. —— Schiedei, *Hook. & B.*	10									
195. —— arborescens, *L'Her.*	..	..	H							
196. —— antarctica, *Lab.*	..	P	..	..	6					
197. —— chrysotricha, *Moore*	..	M								
198. —— Sellowiana, *Hook.*	10									
199. —— squarrosa, *Sw.*	..	..	..	..	6					
200. —— Berteroana, *Hook.*	..	P	..	7						
201. —— culcita, *L'Her.*	..	..	..	..	..	..	..	..	C	
202. —— coniifolia, *Hook.*	10									
203. —— dubia, *Gaud.*	..	P	..	..	A					
204. —— Plumieri, *Hook.*	10									
205. —— sorbifolia, *Sm.*	..	9								
206. —— abrupta, *Bory*	..	..	M							
207. —— adiantoides, *H., B. & K.*	10									
208. —— cicutaria, *Sw.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
209. Dicksonia apiifolia, *Sw.*	10									
210. —— rubiginosa, *Kaulf.*	10	..	M	..	A	..	..	S		
211. —— flaccida, *Sw.*	..	P								
212. —— Moluccana, *Bl.*	..	M								
213. —— davallioides, *R. Br.*	..	A	..	..	A					
214. —— Smithii, *Hook.*	..	M								
215. —— obtusifolia, *Willd.*	10									
216. —— scabra, *Wall.*	..	9	..	..	..	..	..	3		
217. —— punctilobula, *Hook.*	..	..	..	..	..	..	4			
218. —— appendiculata, *Wall.*	..	..	..	..	..	..	..	3		
219. Deparia prolifera, *Hook.*	..	P	..	..	A					
220. —— concinna, *Baker*	10									
221. —— Moorei, *Hook.*	..	P								
Tribe 3. HYMENOPHYLLEÆ.										
222. Loxsoma Cunninghami, *R. Br.*	..	..	..	..	Z					
223. Hymenophyllum cruentum, *Cav.*	..	..	..	7						
224. —— parvifolium, *Baker*	..	M								
225. —— corticola, *Hook.*	..	H								
226. —— marginatum, *Hook. & Gr.*	..	..	..	..	A					
227. —— asplenioides, *Sw.*	10									
228. —— abruptum, *Hook.*	10									
229. —— mnioides, *Baker*	..	P								
230. —— rarum, *R. Br.*	..	..	M	7	Z	5	..	J		
231. —— capillaceum, *Roxb.*	..	..	H							
232. —— gracile, *Bory*	..	..	M	..	A					
233. —— exsertum, *Wall.*	..	H	..	..	..	..	..	3		
234. —— axillare, *Sw.*	10									
235. —— reniforme, *Hook.*	10	..	..	7						
236. —— crispum, *H., B. & K.*	10									
237. —— undulatum, *Sm.*	10									
238. —— myriocarpum, *Hook.*	10									
239. —— microsorum, *V. d. B.*	..	..	..	..	..	..	..	3		
240. —— polyanthos, *Sw.*	10	9	8	7	Z	..	..	3		
241. —— andinum, *V. d. B.*	10									
242. —— badium, *Hook. & Gr.*	..	M	..	..	..	..	..	S		
243. —— Javanicum, *Spreng.*	..	9	..	..	6	..	..	3		
244. —— demissum, *Sw.*	..	9	..	..	Z					
245. —— caudiculatum, *Mart.*	10	..	..	7						
246. —— recurvum, *Gaud.*	..	P			6					
247. —— flabellatum, *Lab.*	..	..	..	..	Z					
248. —— scabrum, *Rich.*	..	..	..	..	Z					
249. —— dilatatum, *Sw.*	..	P	..	..						
250. —— fuciforme, *Sw.*	..	..	..	7						
251. —— pulcherrimum, *Col.*	..	..	..	..	Z					
252. —— Zollingeriahum, *Kze.*	..	M								
253. —— Borneense, *Hook.*	..	M								
254. —— hirsutum, *Sw.*	10									
255. —— Chiloense, *Hook.*	..	..	..	7						
256. —— ciliatum, *Sw.*	10	..	M	7	Z					
257. —— obtusum, *Hook. & Arn.*	..	P	..	..	..	5				
258. —— æruginosum, *Carm.*	..	..	..	..	..	T				
259. —— lanceolatum, *Hook. & Arn.*	..	P		7	Z					
260. —— subtilissimum, *Kze.*	..	..	..							
261. —— hirtellum, *Sw.*	10		M							
262. —— elasticum, *Bory*	..	..								
263. —— Lindeni, *Hook.*	10									
264. —— microcarpum, *Desv.*	10									
265. —— valvatum, *Hook. & Gr.*	10									
266. —— Sprucei, *Baker*	10									
267. —— interruptum, *Kze.*	10									
268. —— sericeum, *Sw.*	..	..	..	..	Z					
269. —— Malingii, *Mett.*	10	..	M							
270. —— lineare, *Sw.*	10									
271. —— elegantulum, *V. d. B.*	10									
272. —— Catherinæ, *Hook.*	10									
273. —— Pastoensis, *Hook.*	10	9	M	7	6	5	..	..	2	
274. —— Tunbridgense, *Sm.*	..	..	..	7						
275. —— Serra, *Presl*	10									
276. —— tenerrimum, *V. d. B.*	10									
277. —— Jamesoni, *Hook.*	..	..	..	..	..	..	..	J		
278. —— barbatum, *Baker*										

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
279. Hymenophyllum secundum, *Hook. & Gr.*	..	..	..	7						
280. —— Simonsianum, *Hook.*	..	..	..	..	..	..	..	3		
281. —— pectinatum, *Cav.*	..	..	..	7						
282. —— multifidum, *Sw.*	..	P	..	..	Z					
283. —— triangulare, *Baker*	..	..	W							
284. —— bivalve, *Sw.*	..	..	..	..	Z					
285. —— Smithii, *Hook.*	..	M								
286. —— flaccidum, *Baker*	..	..	..	..	..	..	..	3		
287. —— fucoides, *Sw.*	10									
288. —— Magellanicum, *Willd.*	10	..	..	7						
289. —— Bridgesii, *Hook.*	..	..	..	7						
290. —— tortuosum, *Hook. & Gr.*	..	..	..	7						
291. —— dichotomum, *Cav.*	..	..	..	7						
292. —— denticulatum, *Sw.*	..	M								
293. —— Neesii, *Hook.*	..	9								
294. —— sabinæfolium, *Baker*	..	M								
295. Trichomanes elegans, *Rudge*	10									
296. —— botryoides, *Kaulf.*	10									
297. —— spicatum, *Hedw.*	10									
298. —— heterophyllum, *H., B. & K.*	10									
299. —— reniforme, *Forst.*	..	..	..	..	Z					
300. —— lineolatum, *Hook.*	10									
301. —— peltatum, *Baker*	..	P								
302. —— membranaceum, *L.*	10									
303. —— cuspidatum, *Willd.*	..	..	M							
304. —— Motleyi, *V. d. B.*	..	9								
305. —— Godmani, *Hook.*	10									
306. —— punctatum, *Poir.*	10									
307. —— reptans, *Sw.*	10									
308. —— Barklianum, *Baker*	..	..	M							
309. —— Vitiense, *Baker*	..	P								
310. —— Neilgheriense, *Bedd.*	..	H								
311. —— Petersii, *A. Gray*	..	..	..	..	..	..	4			
312. —— apodum, *Hook. & Gr.*	10									
313. —— Henzaianum, *Parish*	..	M								
314. —— muscoides, *Sw.*	10	9	8							
315. —— parvulum, *Poir.*	..	9	M	..	..	..	..	C J		
316. —— saxifragoides, *Presl*	..	9								
317. —— Mannii, *Hook.*	..	..	W							
318. —— proliferum, *Blume*	..	9								
319. —— flabellatum, *Bory*	..	..	M							
320. —— Powellii, *Baker*	..	P								
321. —— digitatum, *Sw.*	..	9	M	..	..	5	..	S		
322. —— calvescens, *V. d. B.*	..	..	..	..	A					
323. —— Lyallii, *Hook.*	..	..	..	..	Z					
324. —— nanum, *V. d. B.*	..	..	..	..	..	..	..	S		
325. —— pusillum, *Sw.*	10	M	..	..	..	5				
326. —— Krausii, *Hook. & Gr.*	10									
327. —— Kirkii, *Hook.*	..	..	M							
328. —— sinuosum, *Rich.*	10									
329. —— pinnatifidum, *V. d. B.*	I									
330. —— Bancroftii, *Hook. & Gr.*	10									
331. —— macilentum, *V. d. B.*	10									
332. —— superbum, *V. d. B.*	10									
333. —— Kaulfussii, *Hook. & Gr.*	10									
334. —— alatum, *Sw.*	10									
335. —— bicorne, *Hook.*	10									
336. —— intramarginale, *Hook. & Gr.*	..	H								
337. —— latemarginale, *Eaton*	..	M								
338. —— humile, *Forst.*	..	9	..	..	Z					
339. —— brachypus, *Kunze*	10									
340. —— pallidum, *Blume*	..	9								
341. —— serratulum, *Baker*	..	M								
342. —— Filicula, *Bory*	10	9	8	..	..	5	..	3		
343. —— pyxidiferum, *L.*	10	9	8	..	..	5	..	3		
344. —— radicans, *Sw.*	10	9	8	..	..	..	4	3	2	
345. —— auriculatum, *Blume*	10	M	..	..	..	..	..	3		
346. —— denticulatum, *Baker*	..	M								
347. —— venosum, *R. Br.*	..	..	..	..	6					
348. —— crispum, *L.*	10	..	W	7						
349. —— crinitum, *Sw.*	10									
350. —— lucens, *Sw.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.		
351. Trichomanes Lambertianum, *Hook.*	10											
352. —— cæspitosum, *Hook.*	..	..	..	7								
353. —— Javanicum, *Blume*	..	9	M									
354. —— pinnatum, *Sw.*	10	..	..	7								
355. —— tenue, *Brack.*	..	P										
356. —— brevipes, *Baker*	..	M										
357. —— Smithii, *Hook.*	..	P										
358. —— caudatum, *Brack.*	..	P	..	A								
359. —— tenerum, *Spreng.*	10	..	..	..	..	T						
360. —— exsectum, *Kunze*	..	..	..	7								
361. —— Colensoi, *Hook. fil.*	..	..	..	..	Z							
362. —— trichoideum, *Sw.*	10											
363. —— Lindeni, *Presl*	I											
364. —— rigidum, *Sw.*	10	9	8	..	Z	5	..	J				
365. —— meifolium, *Bory*	..	9	..	..	N							
366. —— maximum, *Bl.*	..	9										
367. —— Prieurii, *Kunze*	10											
368. —— giganteum, *Bory*	..	9	M									
369. —— Sprucei, *Baker*	10											
370. —— gemmatum, *J. Sm.*	10	9										
371. —— longisetum, *Bory*	..	M	M									
372. —— fœniculaceum, *Bory*	..	M	M		A							
Tribe 4. DAVALLIEÆ.												
373. Davallia heterophylla, *Sm.*	..	9										
374. —— angustata, *Wall.*	..	9										
375. —— parallela, *Wall.*	..	9										
376. —— pectinata, *Sm.*	..	P										
377. —— sessilifolia, *Blume*	..	9										
378. —— pedata, *Smith*	..	9	M	..	A				J S			
379. —— alpina, *Blume*	..	9	..	..	..	..	..	..	S			
380. —— pusilla, *Mett.*	..	P										
381. —— vestita, *Blume*	..	9										
382. —— Cumingii, *Hook.*	..	M										
383. —— botrychioides, *Brack.*	..	P										
384. —— Imrayana, *Hook.*	10											
385. —— Parishii, *Hook.*	..	M										
386. —— membranulosa, *Wall.*	..	..	..	..	..	..	..	..	S			
387. —— immersa, *Wall.*	..	9	..	..	..	..	..	..	S			
388. —— multidentata, *Hook.*	..	..	..	..	..	..	..	..	S			
389. —— pulchra, *Don*	..	..	..	..	..	..	..	..	S			
390. —— falcinella, *Presl*	..	M										
391. —— Novæ-Zelandiæ, *Col.*	..	..	..	..	Z				S			
392. —— chœrophylla, *Wall.*	..	9	..	..	..	..	..	..	S			
393. —— parvula, *Wall.*	..	M										
394. —— affinis, *Hook.*	..	9										
395. —— nodosa, *Hook.*	..	M										
396. —— trichomanoides, *Hook.*	..	P										
397. —— hymenophylloides, *Baker*	..	M										
398. —— pulchella, *Hook.*	..	9							S			
399. —— repens, *Desr.*	..	9	M	..	..	..	..	..				
400. —— Parkeri, *Hook.*	10											
401. —— triquetra, *Baker*	..	9										
402. —— Blumeana, *Hook.*	..	M										
403. —— Emersoni, *Hook. & Gr*	..	9										
404. —— contigua, *Sw.*	..	9										
405. —— triphylla, *Hook.*	..	M										
406. —— pentaphylla, *Bl.*	..	M										
407. —— Lobbiana, *Moore*	..	M							S			
408. —— micans, *Mett.*	..	..	..	..	..	..	..	..				
409. —— Moorei, *Hook.*	..	P										
410. —— decurrens, *Hook.*	..	M										
411. —— solida, *Sw.*	..	9				5						
412. —— elegans, *Sw.*	..	9	8	..	..							
413. —— epiphylla, *Blume*	..	M							S			
414. —— divaricata, *Blume*	..	M		..	..							
415. —— mauritiana, *Hook.*	..	..	M						S			
416. —— Griffithiana, *Hook.*	..	M	..	..	..	A						
417. —— pyxidata, *Cav.*	..	..	..	..					S	P		
418. —— canariensis, *Sm.*	..	..	..	..					S			
419. —— bullata, *Wall.*	..	M	..									
420. —— Lorrainei, *Hance*	..	M										

	Torrid zone.			South Temperate zone.			North Temperate zone.			
421. Davallia nitidula, *Kunze*	..	..	W	..	..	5				
422. —— Fijiensis, *Hook.*	..	P								
423. —— Hookeriana, *Wall.*	..	M	..	..	..	..	..	S		
424. —— Sacroloma, *Spr.*	10									
425. —— pinnata, *Cav.*	..	9								
426. —— Wilfordii, *Baker*	..	..	..	..	..	..	..	J		
427. —— pilosella, *Hook.*	..	..	..	..	..	..	..	J		
428. —— ciliata, *Hook.*	..	M								
429. —— villosa, *Wall.*	..	H	..	..	..	..	..	3		
430. —— strigosa, *Sw.*	..	9	..	..	..	..	..	3		
431. —— platyphylla, *Don*	..	H	..	..	..	..	..	S		
432. —— urophylla, *Hook.*	..	..	..	..	..	..	..	S		
433. —— Thwaitesii, *Baker*	..	H								
434. —— inæqualis, *Kunze*	10	9								
435. —— campyleura, *Kunze*	..	9								
436. —— Denhami, *Hook.*	..	P								
437. —— hirta, *Kaulf.*	..	9	..	..	..	..	..	3		
438. —— speluncæ, *Baker*	10	9	8	..	A	5	..	3		
439. —— concinna, *Schrad.*	10	..	8	..	..	5				
440. —— gibberosa, *Sw.*	..	P								
441. —— nigrescens, *Hook.*	..	..	W							
442. —— fœniculacea, *Hook.*	..	P								
443. —— Goudotiana, *Kunze*	..	..	M							
444. —— bifida, *Kaulf.*	10									
445. —— scoparia, *Hook.*	..	P								
446. —— clavata, *Sw.*	I									
447. —— tenuifolia, *Sw.*	..	9	M	..	..	..	..	3		
448. —— uncinella, *Kze.*	I									
449. —— aculeata, *Sw.*	I									
450. —— Melleri, *Hook.*	..	..	M							
451. —— fumarioides, *Sw.*	I									
452. —— Schlechtendahlii, *Pr.*	10									
453. —— Mannii, *Eaton*	..	P								
454. Dystopteris fragilis, *Bernh.*	10	P	8	7	6	5	4	3	2	1
455. —— alpina, *Desv.*	..	..	..	..	..	..	..	W	2	
456. —— bulbifera, *Bernh.*	..	..	..	..	..	..	..			
457. —— sudetica, *B. & M.*	..	..	..	..	..	..	4		2	
458. —— montana, *Link*	..	..	..	..	..	..	..	..	2	1
Tribe 5. LINDSAYEÆ.										
459. Lindsaya linearis, *Sw.*	..	P	..	..	A					
460. —— falciformis, *Hook.*	10									
461. —— adiantoides, *J. Sm.*	..	M								
462. —— ovata, *J. Sm.*	..	M								
463. —— concinna, *J. Sm.*	..	M								
464. —— Seemanni, *J. Sm.*	10									
465. —— cultrata, *Sw.*	..	9	M	..	A	..	..	3		
466. —— botrychioides, *St. Hil.*	10									
467. —— dubia, *Spr.*	10									
468. —— pectinata, *Blume*	..	M	..	..	..	..	..	S		
469. —— scandens, *Hook.*	..	M								
470. —— Lapeyrousii, *Baker*	..	P								
471. —— filiformis, *Hook.*	10									
472. —— Catherinæ, *Hook.*	10									
473. —— virescens, *Sw.*	10									
474. —— flabellulata, *Dry.*	..	9	..	..	..	..	..	S		
475. —— trapeziformis, *Dry.*	10	9								
476. —— Borneensis, *Hook.*	..	M								
477. —— Guianensis, *Dry.*	10									
478. —— stricta, *Dry.*	10									
479. —— rigida, *J. Sm.*	..	M								
480. —— Kirkii, *Hook.*	..	..	S							
481. —— pendula, *Klotzsch*	10									
482. —— Sprucei, *Hook.*	10									
483. —— Parishii, *Baker*	..	M								
484. —— reniformis, *Dry.*	10									
485. —— sagittata, *Dry.*	10									
486. —— Walkeræ, *Hook.*	..	9								
487. —— divergens, *Wall.*	..	M								
488. —— lanuginosa, *Wall.*	..	M	E	..	A					
489. —— alutacea, *Mett.*	..	P								
490. —— trichomanoides, *Dry.*	..	P	..	..	6					

		Tertiá rotat.			South Temperate zone.			North Temperate zone.			Highest zone.
301.	Lindsæa microphylla, *Dry.*	..	..	..	—	C					
302.	—— elongata, *Link*	..	F								
303.	—— rotata, *Mett.*	..	P								
304.	—— media, *R. Br.*	..	A								
305.	—— ensifolia, *Sieber*	..	P	..	—	A					
306.	—— davallioides, *Bl.*		M								
307.	—— cordata, *Gaud.*		M								
308.	—— Gardneriana, *Gaud.*		M								
309.	—— cuneifolia, *Sw.*	..	P	S	..	A	S	..	R		
310.	—— macrophylla, *Kaulf.*	10									
311.	—— Fraseri, *Hook.*	..	..	..	..	A					
312.	—— heterophylla, *Dry.*	..	P	M							
313.	—— pumila, *Hook.*	..	P								
314.	—— erecta, *Hook.*	..	P								
315.	—— falcata, *Hook.*	..	P								
316.	—— Mohlenana, *Eaton*	10									
317.	Dictyoxiphium panamense, *Hook.*	10									
	Tribe 6. Pteridea.										
318.	Adiantum reniforme, *L.*	..		M	—	—	—	..	..	C	
319.	—— Parishii, *Hook.*	..	M								
320.	—— lunulatum, *Burm.*	10	P	P	..	..	..	..	A		
321.	—— Cayennense, *Hance*	..	..	..	..	..	..	..	C		
322.	—— cuneatum, *L.*	..	P	P	..	—	..	..	P		
323.	—— calcareum, *Gard.*	10									
324.	—— Kaulfussii, *Kze.*	10									
325.	—— obliquum, *Willd.*	10									
326.	—— Gibertianum, *Hook.*	10									
327.	—— Peruvianum, *Kl.*	10									
328.	—— subcordatum, *Sw.*	10									
329.	—— intermedium, *Sw.*	10									
330.	—— sinuosum, *Gard.*	10									
331.	—— Shepherdi, *Hook.*	10									
332.	—— diaphanum, *Bl.*	..	P	..	..	A					
333.	—— affine, *Willd.*	..	..	..	..	P					
334.	—— nigrescens, *Fée*	1									
335.	—— trapeziforme, *L.*	10									
336.	—— polyphyllum, *Willd.*	10									
337.	—— glaucescens, *Kl.*	10									
338.	—— Henslovianum, *Hook. fil.*	10									
339.	—— cristatum, *L.*	10									
340.	—— obtusum, *Desv.*	10									
341.	—— hirtum, *Klotzsch*	10									
342.	—— formosum, *Willd.*	..	..	..	—	A					
343.	—— sulcatum, *Hook.*	1									
344.	—— fulvum, *Raoul*	..	P	..	—	A					
345.	—— pubescens, *Bl.*		P								
346.	—— crenatum, *Willd.*	10									
347.	—— pectinatum, *Kze.*	10									
348.	—— tetraphyllum, *Willd.*	10									
349.	—— lucidum, *Sw.*	10									
350.	—— Phyllitidis, *J. Sm.*	10									
351.	—— macrophyllum, *Sw.*	10									
352.	—— Seemanni, *Hook.*	10									
353.	—— deltoideum, *Sw.*	1									
354.	—— villosum, *L.*	10									
355.	—— pulverulentum, *L.*	10									
356.	—— incisum, *Presl*	10									
357.	—— microphyllum, *Kf.*	1									
358.	—— Capillus-veneris, *L.*	10	9	8	..	..	5	4	3	2	
359.	—— scabrum, *L.*	10	9	8	7	6	5	4	..	2	
360.	—— exilium, *Kunze*	..	..	..	7						
361.	—— concinnum, *H., B. & K.*	10									
362.	—— colpodes, *Moore*	10									
363.	—— tenerum, *Sw.*	10									
364.	—— cuneatum, *L. & F.*	10									
365.	—— dissectum, *Hook.*	10									
366.	—— fragile, *Sw.*	1									
367.	—— rotundum, *Don*	..	..	..	..	..	..	..	3		
368.	—— trichomanoides, *Eaton*	..	..	..	..	..	..	..	3		
369.	—— digitatum, *Presl*	10									
370.	—— Féei, *Moore*	10									

2 x 2

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
561. Adiantum pedatum, *L.*	..	..	..	..	..	..	4	3		
562. —— tetragonum, *Schrad.*	10									
563. —— patens, *Willd.*	10									
564. —— hispidulum, *Sw.*	..	9	8	..	6					
565. —— tuberculatum, *L.*	..	9	..	..	..	..	..	3		
566. —— Hewardia, *Kunze*	10									
567. —— dolosum, *Kunze*	10									
568. —— olivaceum, *Baker*	10									
569. —— Leprieurii, *Hook.*	10									
570. Ochropteris pallens, *J. Sm.*	..	..	M							
571. Lonchitis pubescens, *Willd.*	10	..	8	..	..	5				
572. —— occidentalis, *Baker*	..	..	W							
573. Hypolepis tenuifolia, *Bernh.*	..	9	..	..	6					
574. —— distans, *Hook.*	..	..	..	..	Z					
575. —— anthriscifolia, *Presl*	..	..	8	..	..	5				
576. —— repens, *Presl*	10									
577. —— hostilis, *Presl*	10									
578. —— nigrescens, *Hook.*	10									
579. —— Purdieana, *Hook.*	10									
580. —— parallelogramma, *Hook.*	10									
581. —— Millefolium, *Hook.*	..	..	..	..	Z					
582. —— Bergiana, *Hook.*	..	..	E	..	..	5				
583. —— Californica, *Hook.*	..	..	..	..	..	..	4			
584. Cheilanthes monticola, *Gard.*	10									
585. —— Lindigii, *Mett.*	10									
586. —— pteroides, *Sw.*	..	M	..	..	..	5				
587. —— regularis, *Mett.*	10									
588. —— paupercula, *Mett.*	I									
589. —— radiata, *R. Br.*	10									
590. —— capensis, *Sw.*	..	..	..	..	..	5				
591. —— Kirkii, *Hook.*	..	..	8							
592. —— pedata, *R. Br.*	I									
593. —— propinqua, *Mett.*	10									
594. —— dichotoma, *Sw.*	10	..	..	7						
595. —— Seemanni, *Hook.*	10									
596. —— Schimperi, *Hook.*	..	..	E							
597. —— incisa, *Kunze*	10									
598. —— chlorophylla, *Sw.*	10	..	..	7						
599. —— micropteris, *Sw.*	10	..	..	7						
600. —— Matthewsii, *Kunze*	10									
601. —— fragrans, *W. & B.*	10	..	..	..	..	..	..	3	2	
602. —— arabica, *Dec.*	..	W	E							
603. —— vestita, *Sw.*	..	..	..	..	..	..	4			
604. —— pilosa, *Goldm.*	10									
605. —— microphylla, *Sw.*	10									
606. —— Mysurensis, *Wall.*	..	9	..	..	..	..	..	C J		
607. —— fragilis, *Hook.*	..	M								
608. —— hirta, *Sw.*	..	M	W	..	..	5				
609. —— viscosa, *Kaulf.*	10	..	..	..	..	..	4			
610. —— hispanica, *Mett.*	..	..	..	..	..	..	..	..	2	
611. —— pulchella, *Bory*	..	..	..	..	..	..	..		C	
612. —— varians, *Hook.*	..	M	..	..	..	..	..	S		
613. —— subvillosa, *Hook.*	..	..	..	..	..	..	..	S		
614. —— Dalhousiæ, *Hook.*	..	..	..	..	..	..	..	3		
615. —— allosuroides, *Mett.*	10									
616. —— Sieberi, *Kunze*	..	P	..	..	6					
617. —— bullata, *Kunze*	..	H								
618. —— multifida, *Sw.*	..	M	8	..	..	5				
619. —— Wrightii, *Hook.*	..	..	..	..	..	..	4			
620. —— tenuifolia, *Sw.*	..	9	..	..	6	..	..	S		
621. —— flexuosa, *Kunze*	10									
622. —— induta, *Kunze*	..	..	..	..	..	5				
623. —— lanuginosa, *Nutt.*	..	..	..	..	..	..	4			
624. —— Szovitzii, *F. & M.*	..	..	..	..	..	..	..	3	2	
625. —— gracillima, *Eaton*	..	..	..	..	..	..	4			
626. —— Fendleri, *Hook.*	..	..	..	..	..	..	4			
627. —— Lindheimeri, *Hook.*	..	..	..	..	..	..	4			
628. —— myriophylla, *Desv.*	10	H	..	7						
629. —— scariosa, *Kaulf.*	10									
630. —— Eatoni, *Baker*	..	..	..	..	..	..	4			
631. —— tomentosa, *Link*	10	..	..	..	..	..	4			
632. —— lendigera, *Sw.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
633. Cheilanthes speciosissima, *A. Br.*	10									
634. —— rufa, *Desv.*										
635. —— aurea, *Baker*	10									
636. —— aurantiaca, *Moore*	10									
637. —— Welwitschii, *Hook.*			W							
638. —— argentea, *Hook.*		M								
639. —— farinosa, *Kaulf.*	10	9	8							
640. Casebeera triphylla, *Kaulf.*	10									
641. —— pinnata, *Kaulf.*	10									
642. —— gleichenioides, *Gard.*	10									
643. Onychium melanolepis, *Dec.*			E					W		
644. —— strictum, *Kunze*	1									
645. —— auratum, *Kaulf.*		M						8		
646. —— japonicum, *Kunze*		M						8		
647. Llavea cordifolia, *Lag.*	10									
648. Cryptogramme crispa, *R. Br.*							4	8	9	1
649. Pellæa auriculata, *Link*						5				
650 —— Breweri, *Eaton*							4			
651. —— Seemanni, *Hook.*	10									
652. —— gracilis, *Hook.*							4	3		
653. —— pilosa, *Hook.*			M							
654. —— columbina, *Hook.*	10									
655. —— geraniæfolia, *Fée*	10	9	E	7	A	5		6		
656. —— Tamburii, *Hook.*								8		
657. —— deltoidea, *Baker*						5				
658. —— Skinneri, *Hook.*	10									
659. —— rigida, *Hook.*	10									
660. —— ambigua, *Baker*	10									
661. —— atropurpurea, *Link*	10						4			
662. —— dura, *Hook.*			S			5				
663. —— ternifolia, *Fée*	10	P		7						
664. —— mucronata, *Eaton*	10						4			
665. —— profusa, *J. Sm.*						5				
666. —— aspera, *Baker*							4			
667. —— Alabamensis, *Baker*							4			
668. —— intramarginalis, *J. Sm.*	10									
669. —— ornithopus, *Hook.*							4			
670. —— nitidula, *Baker*										
671. —— densa, *Hook*							4			
672. —— robusta, *Hook.*						5				
673. —— Boivini, *Hook.*		H	M			5				
674. —— andromedæfolia, *Fée*	10			7		5	4			
675. —— pulchella, *Fée*	10						4			
676. —— consobrina, *Hook.*						5				
677. —— angustifolia, *Baker*	10									
678. —— glauca, *J. Sm.*	10			7						
679. —— marginata, *Baker*	10			7						
680. —— Barklyæ, *Baker*							4			
681. —— Bridgesii, *Hook.*										
682. —— rotundifolia, *Hook.*										
683. —— falcata, *Fée*		9								
684. —— paradoxa, *Hook.*										
685. —— Doniana, *Hook.*						5				
686. —— hastata, *Link*						5				
687. —— calomelanos, *Link*							4			
688. —— cordata, *J. Sm.*	10					5				
689. —— Burkeana, *Baker*			M							
690. —— articulata, *Baker*	10	9	8		A	6		8	2	
691. Pteris longifolia, *L.*		9								
692. —— moluccana, *Blume*		M								
693. —— opaca, *J. Sm.*		9				6	4	3	9	
694. —— crotica, *L.*	10	9	W					8		
695. —— pellucida, *Presl*		H								
696. —— Hookeriana, *Ag.*								8		
697. —— dactylina, *Hook.*					A					
698. —— umbrosa, *R. Br.*		A				5		C		
699. —— serrulata, *L. fil.*								8		
700. —— cretata, *Sw.*		9								
701. —— distans, *J. Sm.*		M								
702. —— heteromorpha, *Fée*		M						8		
703. —— Griffithii, *Hook.*										
704. —— madagascarica, *Ag.*			M							

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
705. Pteris mutilata, *L.*	I									
706. —— semipinnata, *L.*	..	9	..	..	..	..	..	S		
707. —— paucinervata, *Fée*	10									
708. —— litobrochioides, *Kl.*	10									
709. —— marattiæfolia, *Hook.*	..	..	..	7						
710. —— Dalhousiæ, *Hook.*	..	M								
711. —— irregularis, *Kaulf.*	..	P								
712. —— quadrimurita, *Retz.*	10	9	8	..	A	5	..	3		
713. —— longipinnula, *Wall.*	..	M	..	..	..	..	..	S		
714. —— excelsa, *Gaud.*	..	9	..	..	..	..	..	3		
715. —— pungens, *Willd.*	I									
716. —— scabra, *Bory*	..	..	M							
717. —— paleacea, *Roxb.*	..	..	H							
718. —— Novæ-Caledoniæ, *Hook.*	..	P								
719. —— heterophylla, *L.*	10									
720. —— gracilis, *Fée*	10									
721. —— laciniata, *Willd.*	10									
722. —— arguta, *Ait.*	..	..	..	..	..	..	..	..	2	
723. —— flabellata, *Thunb.*	..	..	8	..	..	5				
724. —— tremula, *R. Br.*	..	..	..	..	6					
725. —— Chilensis, *Desv.*	10	..	W	7						
726. —— pellucens, *Ag.*	..	M	..	..	..	..	..	3		
727. —— deflexa, *Link*	10									
728. —— coriacea, *Desv.*	10									
729. —— brevisora, *Baker*	..	W								
730. —— aquilina, *L.*	10	9	8	..	6	5	4	3	2	1
731. —— viscosa, *Baker*	10	P								
732. —— scaberula, *Rich*	..	..	..	..	Z					
733. —— rugulosa, *Lab.*	..	P								
734. —— lomariacea, *Kunze*	10									
735. —— grandifolia, *L.*	10									
736. —— biaurita, *L.*	10	9	8	..	..	..	..	3		
737. —— patens, *Hook.*	..	9								
738. —— triplicata, *Ag.*	..	..	E							
739. —— Melleri, *Baker*	..	..	M							
740. —— Wallichiana, *Ag.*	..	M	..	..	..	..	..	3		
741. —— lonchophora, *Mett.*	10									
742. —— sagittifolia, *Raddi*	10									
743. —— ludens, *Wall.*	..	M								
744. —— ornithopus, *Mett.*	10									
745. —— palmata, *Willd.*	10	H								
746. —— pedata, *L.*	10									
747. —— decipiens, *Hook.*	..	P								
748. —— Feliciennæ, *Muell.*	..	..	..	..	A					
749. —— decora, *Brack.*	..	P								
750. —— Vieillardi, *Mett.*	..	P								
751. —— lanceæfolia, *Ag.*	..	..	M							
752. —— splendens, *Kaulf.*	10									
753. —— Mannii, *Baker*	..	..	W							
754. —— laurea, *Desv.*	..	..	M							
755. —— Currori, *Hook.*	..	..	W							
756. —— denticulata, *Sw.*	10									
757. —— Haenkeana, *Presl*	10									
758. —— pulchra, *Schlecht.*	10									
759. —— macroptera, *Link*	10									
760. —— vestita, *Baker*	10									
761. —— Junghuhnii, *Baker*	..	M								
762. —— ciliaris, *Eaton*	I									
763. —— spinulifera, *Schum.*	..	..	W							
764. —— woodwardioides, *Bory*	..	..	M							
765. —— Milneana, *Baker*	..	P	..	..	A					
766. —— decurrens, *Presl*	10									
767. —— macilenta, *Cunn.*	..	..	..	..	Z					
768. —— comans, *Forst.*	..	P	..	7	6					
769. —— aculeata, *Sw.*	10									
770. —— leptophylla, *Sw.*	10									
771. —— incisa, *Thunb.*	10	9	8	7	6	5	..	3		
772. —— tripartita, *Sw.*	..	9	8	..	A	..	..	S		
773. —— Luschnathiana, *Baker*	10									
774. —— podophylla, *Sw.*	10									
775. —— Kunzeana, *Ag.*	10									
776. —— elata, *Ag.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
777. Pteris gigantea, *Willd.*	10									
778. —— latifolia, *H., B. & K.*	10									
779. Ceratopteris thalictroides, *Brong.*	10	9	8	..	..	..	..	8		
780. Lomaria Patersoni, *Spr.*	..	9	..	..	6					
781. —— Vieillardi, *Baker*	..	P								
782. —— ciliata, *Moore*	..	P								
783. —— gibba, *Lab.*	..	P								
784. —— discolor, *Willd.*	..	..	..	..	6					
785. —— attenuata, *Willd.*	10	P	8	7	6	5				
786. —— Lherminieri, *Bory*	10	..	..	7						
787. —— divergens, *Kunze*	10									
788. —— vulcanica, *Blume*	..	9	..	..	6					
789. —— opaca, *Baker*	..	P								
790. —— lanceolata, *Spr.*	..	P	..	..	6					
791. —— blechnoides, *Bory*	..	..	..	7						
792. —— dura, *Moore*	..	..	..	..	N					
793. —— aspera, *Klotzsch*	..	..	..	7						
794. —— onocleoides, *Spr.*	10									
795. —— obtusata, *Lab.*	..	P								
796. —— Spicant, *Desv.*	..	..	..	..	..	..	4	C J	2	1
797. —— alpina, *Spr.*	10	..	..	7	6	T				
798. —— Banksii, *Hook. fil.*	..	..	..	..	Z					
799. —— pumila, *Raoul*	..	..	..	..	Z					
800. —— punctulata, *Kunze*	..	..	M	..	..	5				
801. —— procera, *Spr.*	10	9	..	7	6	5				
802. —— caudata, *Baker*	10									
803. —— Boryana, *Willd.*	10	..	8	7	..	5				
804. —— acuta, *Desv.*	10									
805. —— filiformis, *Cunn.*	..	P	..	..	Z					
806. —— Germainii, *Hook.*	..	..	..	7	..	..	..	J		
807. —— nigra, *Colen.*	..	..	..	..	Z					
808. —— fluviatilis, *Spr.*	..	..	..	..	6					
809. —— membranacea, *Col.*	..	..	..	..	Z					
810. —— diversifolia, *Baker*	..	P								
811. —— Lenormandi, *Baker*	..	P								
812. —— Fraseri, *Cunn.*	..	..	..	..	Z					
813. —— volubilis, *Hook.*	10									
814. —— semicordata, *Baker*	10									
815. —— adnata, *Blume*	..	M	..	..	..	..	..	S		
816. —— glauca, *Blume*	..	M	..	..	..	..	..	3		
817. —— pycnophylla, *Kunze*	..	M	..	..	..	..	..	3		
818. —— euphlebia, *Kunze*	..	M	..	..	A	..	..	3		
Tribe 7. Blechneæ.										
819. Blechnum lanceola, *Sw.*	10									
820. —— asplenioides, *Sw.*	10									
821. —— unilaterale, *Willd.*	10									
822. —— cartilagineum, *Sw.*	..	..	..	..	A					
823. —— nitidum, *Presl*	10	M	..	..	..	..	..	S		
824. —— brasiliense, *Desv.*	10									
825. —— longifolium, *H., B. & K.*	10									
826. —— Fendleri, *Hook.*	10									
827. —— occidentale, *L.*	10	..	..	7						
828. —— arcuatum, *C. Gay*	..	..	..	7						
829. —— hastatum, *Kaulf.*	..	..	..	7						
830. —— australe, *L.*	..	..	M	..	..	5				
831. —— lævigatum, *Cav.*	..	..	..	..	A					
832. —— serrulatum, *Rich.*	10	9	..	..	A	..	4	S		
833. —— orientale, *L.*	..	9	..	..	A	..	..	3		
834. —— melanopus, *Hook.*	..	..	..	..	..	..	..	S		
835. —— Finlaysonianum, *Wall.*	..	M								
836. —— volubile, *Kaulf.*	10									
837. Sadleria cyatheoides, *Kaulf.*	..	9								
838. —— squarrosa, *Gaud.*	..	P								
839. Woodwardia radicans, *Sm.*	10	M	..	..	..	..	4	3	2	
840. —— orientalis, *Sw.*	..	..	..	..	..	..	..	C J		
841. —— Virginica, *Sm.*	..	..	..	..	..	..	4			
842. —— japonica, *Sw.*	..	..	..	..	..	..	..	C J		
843. —— areolata, *Moore*	..	..	..	..	..	..	4			
844. —— Harlandii, *Hook.*	..	M								
845. Doodia aspera, *R. Br.*	..	..	..	..	A					
846. —— blechnoides, *Cun.*	..	..	..	..	A					

	Torrid zone.			South Temperate zone.			North Temperate. zone.			Frigid zone.
847. *Doodia dives, Kunze*	..	9								
848. —— *media, R. Br.*	..	P	..	..	6					
849. —— *caudata, R. Br.*	..	P	..	..	6					
Tribe 8. ASPLENIEÆ.										
850. Asplenium nidus, *L.*	..	9	M	..	A	..	..	3		
851. —— *Grevillei, Wall.*	..	..	..	..	..	..	..	S		
852. —— *Simonsianum, Hk.*	..	..	..	..	..	..	..	S		
853. —— *ensiforme, Wall.*	..	9	..	..	..	..	..	3		
854. —— *angustum, Sw.*	10									
855. —— *concolor, Hook.*	..	M	W							
856. —— *sinuatum, Beauv.*	..	..	W							
857. —— *Currori, Hook.*	..	..	W							
858. —— *coriaceum, Baker*	..	..	W							
859. —— *squamulatum, Bl.*	..	M								
860. —— *scolopendrioides, J. Sm.*	..	M								
861. —— *Sundense, Blume*	..	9								
862. —— *Fijiense, Brack.*	..	P								
863. —— *simplicifrons, Muell.*	..	..	..	..	A					
864. —— *Griffithianum, Hook.*	..	..	..	..	..	..	..	S		
865. —— *Gautieri, Hook.*	..	..	M							
866. —— *serratum, L.*	10	P								
867. —— *subhastatum, Hook.*	10									
868. —— *trilobum, Cav.*	10	..	..	7						
869. —— *Hemionitis, L.*	..	..	W	..	..	..	..	..	2	
870. —— *attenuatum, R. Br.*	..	..		..	A					
871. —— *variabile, Hook.*	..	..	W							
872. —— *pinnatifidum, Nutt.*	..	..	..	..	..	..	4			
873. —— *alternans, Wall.*	..	..	E	..	..	..	..	3		
874. —— *projectum, Kunze*	10									
875. —— *viride, Huds.*	..	..	..	..	..	..	4	3	2	1
876. —— *Kraussii, Moore*	..	..	..	..	..	5				
877. —— *fragile, Presl*	10									
878. —— *Gilliesianum, Hook.*	..	..	..	7						
879. —— *vagans, Baker*	..	..	W							
880. —— *flabellifolium, Cav.*	..	..	..	..	A					
881. —— *Quitense, Hook.*	10									
882. —— *Sandersoni, Hook.*	..	..	8	..	..	5				
883. —— *dentatum, L.*	10									
884. —— *pygmæum, Hook.*	..	..	M							
885. —— *Heufleri, Reich.*	..	..	..	..	..	..	..	..	2	
886. —— *Trichomanes, L.*	10	P	..	..	6	5	4	3	2	
887. —— *arcuatum, Liebm.*	10									
888. —— *extensum, Fée*	10									
889. —— *Petrarchæ, DC.*	..	..	..	..	..	..	..	..	2	
890. —— *monanthemum, L.*	10	P	E	7	..	5	..	..	C	
891. —— *multijugum, Wall.*	..	H	..	..	..	..	..	3		
892. —— *subavenium, Hook.*	..	M	M							
893. —— *ebeneum, Ait.*	10	..	..	..	..	5	4			
894. —— *septentrionale, L.*	..	..	..	..	..	..	4	3	2	
895. —— *Seelosii, Lieb.*	..	..	..	..	..	..	..	..	2	
896. —— *angustifolium, Mich.*	..	..	..	..	..	..	4			
897. —— *multilineatum, Hook.*	..	P	..	..	..	..				
898. —— *longissimum, Blume*	..	M	M							
899. —— *Wightianum, Wall.*	..	H	..							
900. —— *Sumatranum, Hook.*	..	9	..							
901. —— *salignum, Blume*	..	M								
902. —— *alatum, H., B. & K.*	10									
903. —— *Vieillardi, Mett.*	..	P								
904. —— *salicifolium, L.*	10									
905. —— *longicauda, Hook.*	..	..	W							
906. —— *emarginatum, Beauv.*	..	..	W							
907. —— *virens, Presl*	10									
908. —— *vulcanicum, Bl.*	..	M								
909. —— *oligophyllum, Kaulf.*	10	M								
910. —— *tenerum, Forst.*	..	9	W							
911. —— *lineatum, Sw.*	..	..	M							
912. —— *prionurus, J. Sm.*	..	M								
913. —— *erectum, Bory*	10	9	8	7	..	5				
914. —— *persicifolium, J. Sm.*	..	9								
915. —— *obtusifolium, L.*	10									
916. —— *fuliginosum, Hook.*	..	M								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
917. Asplenium Borneense, *Hook.*	..	M								
918. —— firmum, *Kunze*	10									
919. —— cultrifolium, *L.*	10									
920. —— auriculatum, *Sw.*	10									
921. —— Prionitis, *Kunze*	..	..	W	..	..	5				
922. —— anisophyllum, *Kunze*	10	..	8	..	..	5				
923. —— Wrightii, *Eaton*	..	..	..	..	..	..	..	J		
924. —— rhizophorum, *L.*	10	P								
925. —— anisodontum, *Pr.*	..	M								
926. —— contiguum, *Kaulf.*	..	9								
927. —— hirtum, *Kaulf.*	..	9	M							
928. —— hastatum, *Klotzsch*	10	..	..	7						
929. —— enatum, *Brack.*	..	P								
930. —— compressum, *Sw.*	..	..	H							
931. —— vomeriforme, *Hook.*	10									
932. —— macrosorum, *Bert.*	..	..	..	7						
933. —— nitens, *Sw.*	..	..	M							
934. —— platybasis, *Kunze*	..	..	H							
935. —— serra, *L. & F.*	10	..	W	..	..	5				
936. —— marinum, *L.*	10	..	..	..	..	..	4	..	2	
937. —— obtusatum, *Forst.*	10	..	..	7	6	T				
938. —— gemmiferum, *Schrad.*	..	..	8	..	..	5				
939. —— auritum, *Sw.*	10	H	M							
940. —— paleaceum, *R. Br.*	..	A								
941. —— Hancei, *Baker*	..	M								
942. —— erosum, *L.*	I									
943. —— falcatum, *L.*	..	9	8	..	6					
944. —— caudatum, *Forst.*	..	9	M	..	A					
945. —— dimidiatum, *Sw.*	10	..	W							
946. —— macrophyllum, *Sw.*	..	9	M	..	..	..	..	S		
947. —— paradoxum, *Blume*	..	M								
948. —— obesum, *Baker*	10									
949. —— formosum, *Willd.*	10	H	W							
950. —— pulchellum, *Raddi*	10									
951. —— resectum, *Sm.*	..	9	8	..	..	..	..	3		
952. —— lætum, *Sw.*	10							S		
953. —— heterocarpum, *Wall.*	..	9	..	..	..	..	..	3		
954. —— planicaule, *Wall.*	..	H	..	..	..	..	..	3		
955. —— laciniatum, *Don*	..	..	..	..	..	..	..			
956. —— bissectum, *Sw.*	10									
957. —— horridum, *Kaulf.*	..	9								
958. —— protensum, *Schrad.*	..	..	7	..	..	5				
959. —— Hallii, *Hook.*	10									
960. —— mucronatum. *Presl*	10									
961. —— bipartitum, *Bory*	..	..	M							
962. —— pumilum, *Sw.*	10	..	E						2	
963. —— germanicum, *Weiss*	..	..	..	..	..	..	..	..	..	
964. —— Ruta-muraria, *L.*	..	..	..	..	..	5	4	3	2	1
965. —— Hookerianum, *Col.*	..	..	..	..	Z					
966. —— magellanicum, *Kaulf.*	..	..	..	7						
967. —— fissum, *Kit.*	..	..	..	..	..	..	..	..	2	
968. —— sepulchrale, *Hook.*	..	..	..	..	..	..	..	C J		
969. —— montanum, *Willd.*	..	..	..	..	..	..	4			
970. —— Adiantum-nigrum, *L.*	..	P	8	..	..	5	..	3	2	
971. —— solidum, *Kunze*	..	..	..	..	..	5				
972. —— dissectum, *Brack.*	..	P								
973. —— cuneatum, *Lam.*	10	9	8	..	..	5				
974. —— furcatum, *Thunb.*	10	9	8	..	A	5	..	3	C	
975. —— affine, *Sw.*	..	9	M					3		
976. —— nitidum, *Sw.*	..	9	..	..	..	..	..	S		
977. —— laserpitiifolium, *Lam.*	..	9	..	..	..	5	..			
978. —— nigritianum, *Hook.*	..	..	W							
979. —— scandicinum, *Kaulf.*	10									
980. —— fragrans, *Sw.*	10							C		
981. —— Blakistoni, *Baker*	..	..	..	..	..	..	..	3	2	
982. —— fontanum, *Bernh.*	10	..	..	..	..	..	..	3		
983. —— varians, *Hook. & Gr.*	..	H	..	..	..	5	..			
984. —— incisum, *Thunb.*	..	..	..	..	..	..	C J			
985. —— lanceolatum, *Huds.*	..	..	H	..	..	..	..	..	2	
986. —— angustatum, *Presl.*	10									
987. —— adiantoides, *Raddi*	10							J		
988. —— Wardii, *Hook.*	..	..	..	..	..	..	..			

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
989. Asplenium pseudo-nitidum, *Rad.*	10									
990. —— Jamesoni, *Hook.*	10									
991. —— acuminatum, *H. & A.*	..	P								
992. —— squamosum, *L.*	10									
993. —— bulbiferum, *Forst.*	10	9	M	..	6	5	..	3		
994. —— triphyllum, *Presl*	10									
995. —— repens, *Hook.*	10									
996. —— delicatulum, *Presl*	10									
997. —— divaricatum, *Kunze*	10	..	..	7						
998. —— Gibertianum, *Hook.*	..	..	..	7						
999. —— Colensoi, *Hook. fil.*	..	..	..	..	Z					
1000. —— Fadyeni, *Hook.*	I									
1001. —— tenuifolium, *Don*	..	9	..	..	..	..	..	3		
1002. —— rhizophyllum, *Kunze*	10	P	..	..	..	5	4			
1003. —— rutaceum, *Mett.*	10	..	..	..	..	..				
1004. —— cicutarium, *Sw.*	10	..	8	..	..	5				
1005. —— Mannii, *Hook.*	..	..	8							
1006. —— brachypteron, *Kunze*	..	..	8	..	..	5				
1007. —— Dregeanum, *Kunze*	..	..	..	..	..	5				
1008. —— obtusilobum, *Hook.*	..	P								
1009. —— dichotomum, *Hook*	..	M								
1010. —— bipinnatifidum, *Brack.*	..	P								
1011. —— davallioides, *Hook.*	..	M	..	..	..	..	..	C J		
1012. —— irregulare, *Baker*	..	..	W							
1013. —— Richardi, *Hook. fil.*	..	..	..	..	Z					
1014. —— flaccidum, *Forst.*	..	P	..	..	6	5				
1015. —— rutæfolium, *Kunze*	..	P	E	..	..	5	..	S		
1016. —— borbonicum, *Hook.*	..	..	M							
1017. —— Belangeri, *Kunze*	..	M								
1018. —— Thunbergii, *Kunze*	..	..	W	..	..	5				
1019. —— viviparum, *Presl.*	..	..	M							
1020. —— Novæ-Caledoniæ, *Hook.*	..	P								
1021. —— dimorphum, *Kunze*	..	..	..	..	N					
1022. —— scandens, *J. Sm.*	..	9								
1023. —— multifidum, *Brack.*	..	P								
1024. —— Powellii, *Baker*	..	P								
1025. —— ferulaceum, *Moore*	10									
1026. —— Hillebrandi, *Baker*	..	9								
1027. —— crenatum, *Fries*	..	..	..	..	..	..	..	C J	2	1
1028. —— spinulosum, *Baker*	..	..	..	..	..	..	..	C		
1029. —— subtriangulare, *Hook.*	..	..	..	..	..	..	..	3		
1030. —— medium, *Hook.*	..	..	..	..	..	T				
1031. —— cystopteroides, *Hook.*	..	..	..	..	..	..	..	J		
1032. —— Hohenackerianum, *Kunze*	..	9	..	..	..	..	..	S		
1033. —— grammitoides, *Hook.*	..	9								
1034. —— thelypteroides, *Michx.*	..	M	..	..	..	4	3			
1035. —— decurtatum, *Link*	10									
1036. —— deparioides, *Brack.*	..	P								
1037. —— Skinneri, *Baker*	10									
1038. —— achilleæfolium, *Liebm.*	10									
1039. —— macrocarpum, *Blume*	..	9	..	..	..	..	..	3		
1040. —— nigripes, *Blume*	..	9	..	..	..	..	..	3		
1041. —— niponicum, *Mett.*	..	..	..	..	..	..	..	J		
1042. —— Filix-fœmina, *Bernh.*	10	9	8	7	..	5	4	3	2	1
1043. —— oxyphyllum, *Hook.*	..	M	..	..	..	..	..	3		
1044. —— aspidioides, *Schlecht.*	10	9	8	..	..	5				
1045. —— brevisorum, *Wall.*	..	9	..	..	..	..	..	S		
1046. —— conchatum, *Moore*	I									
1047. —— fimbriatum, *Hook.*	..	..	..	..	..	..	..	3		
1048. —— umbrosum, *J. Sm.*	10	9	W	..	6	..	..	3	C	
1049. —— woodwardioides, *Baker*	..	M								
1050. —— lanceum, *Thunb.*	..	H	..	..	..	..	..	S		
1051. —— subserratum, *Bl.*	..	M								
1052. —— plantagineum, *L.*	10									
1053. —— zeylanicum, *Hook.*	..	H								
1054. —— humile, *Baker*	..	..	M							
1055. —— pallidum, *Bl.*	..	M								
1056. —— porrectum, *Wall.*	..	M								
1057. —— cultratum, *Mett.*	..	M								
1058. —— pinnatifido-pinnatum, *Hook.*	..	..	..	..	..	..	..	S		
1059. —— Seemannii, *Baker*	10									
1060. —— bantamense, *Baker*	..	9	..	..	..	..	..	S		

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1061. Asplenium Lechleri, *Mett.*	10									
1062. —— Callipteris, *Baker*	10									
1063. —— grandifolium, *Sw.*	10	M								
1064. —— flavescens, *Mett.*	10									
1065. —— rhoifolium, *Mett.*	10									
1066. —— celtidifolium, *Kunze*	10	M								
1067. —— sylvaticum, *Presl*	10	9	8							
1068. —— arboreum, *Willd.*	10									
1069. —— Wichuræ, *Mett.*	..	..	..	..	..	..	..	J		
1070. —— Shepherdi, *Spr.*	10									
1071. —— semihastatum, *Kunze*	I									
1072. —— longifolium, *Don*	..	..	..	..	..	..	..	S		
1073. —— Brackenridgii, *Baker*	..	9								
1074. —— tomentosum, *Hook.*	..	M	..	..	..	..	..	S		
1075. —— Sprucei, *Baker*	10									
1076. —— japonicum, *Thunb.*	..	9	..	..	..	..	..	3		
1077. —— Thwaitesii, *A. Br.*	..	H								
1078. —— lasiopteris, *Mett.*	..	9								
1079. —— speciosum, *Mett.*	..	M								
1080. —— Welwitschii, *Hook.*	..	..	W							
1081. —— crenulatum, *Baker*	10									
1082. —— Lindbergii, *Mett.*	10									
1083. —— Sorzogonense, *Presl*	..	M	..	..	..	..	..	S		
1084. —— costale, *Swartz*	10									
1085. —— Franconis, *Mett.*	10									
1086. —— deltoideum, *Presl*		M								
1087. —— virescens, *Mett.*	..	..	..	..	..	..	..	J		
1088. —— squamigerum, *Mett.*	..	..	..	..	..	..	..	J		
1089. —— Chinense, *Baker*	..	..	..	..	..	..	..	C		
1090. —— nervosum, *Mett.*	10									
1091. —— venulosum, *Baker*	10									
1092. —— cyatheæfolium, *Bory*	..	M								
1093. —— Meyenianum, *Mett.*	..	M								
1094. —— polypodioides, *Mett.*	..	9	M	..	A	..	..	3		
1095. —— Griffithii, *Baker*	..	..	..	..	..	..	..	S		
1096. —— maximum, *Don*	..	9	..	..	..	..	..	3		
1097. —— melanochlamys, *Hook.*	..	..	..	..	N					
1098. —— vestitum, *Presl*	..	M								
1099. —— latifolium, *Don*	..	9	..	..	..	..	..	3		
1100. —— nigropaleaceum, *Baker*	..	..	H							
1101. —— arborescens, *Mett.*	..	P	M							
1102. —— melanocaulon, *Baker*	..	P								
1103. —— Arnottii, *Baker*	..	P								
1104. —— pulicosum, *Hook*	10									
1105. —— Klotzschii, *Mett.*	10									
1106. —— flexuosum, *Presl*	10									
1107. —— vastum, *Mett.*	10									
1108. —— hians, *Kunze*	10									
1109. —— radicans, *Schk.*	10									
1110. —— gracilescens, *Mett.*	10									
1111. —— Sandwichianum, *Mett.*	10	P								
1112. —— Wilsoni, *Baker*	I									
1113. —— divissimum, *Baker*	10									
1114. —— ternatum, *Hook.*	10									
1115. —— Kunzei, *Mett.*	10									
1116. —— cordifolium, *Mett.*	..	M								
1117. —— alismæfolium, *Hook.*	..	M								
1118. —— lineolatum, *Mett.*	..	M						S		
1119. —— heterophlebium, *Mett.*	..	..	..	..	..	..	..			
1120. —— decussatum, *Sw.*	..	9	8	..	A					
1121. —— chimborazense, *Spruce*	10									
1122. —— rivale, *Spruce*	10									
1123. —— stenocarpum, *Mett.*	10							S		
1124. —— esculentum, *Presl*	..	9	..	..	..	..	..			
1125. —— Smithianum, *Baker*	..	H								
1126. —— Vitiense, *Baker*	..	P						3	2	
1127. —— Ceterach, *L.*	..	..	..	..	..	..	..			
1128. —— Purdieanum, *Hook.*	10							3		
1129. —— Finlaysonianum, *Wall.*	..	M	..	..	..	..	..			
1130. —— marginatum, *L.*	10							S	2	
1131. Actiniopteris radiata, *Link*	..	H	8	..	..	5	..	3		
1132. Allantodia Brunoniana, *Wall.*	..	9	..	..	..	..	..			

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
Tribe 9. SCOLOPENDRIEÆ.										
1133. Scolopendrium vulgare, *Sym.*	10	..	..	..	..	..	4	C	2	
1134. —— Hemionitis, *Sw.*	..	..	..	..	..	..	..	..	2	
1135. —— pinnatum, *J. Sm.*	..	M								
1136. —— Durvillei, *Bory*	..	M								
1137. —— brasiliense, *Kunze*	10									
1138. —— plantagineum, *Schrad.*	10									
1139. —— nigripes, *Hook.*	10									
1140. —— rhizophyllum, *Hook.*	..	..	..	..	..	..	4			
1141. —— sibiricum, *Hook.*	..	..	..	..	..	..	..	C J		
Tribe 10. ASPIDIEÆ.										
1142. Didymochlæna lunulata, *Desv.*	10	9	8	..	..	5				
1143. —— polycarpa, *Baker*	..	M								
1144. Aspidium glandulosum, *H. & G.*	I									
1145. —— Plaschnichianum, *Kunze*	I									
1146. —— rhizophyllum, *Sw.*	I									
1147. —— semicordatum, *Sw.*	10	M								
1148. —— munitum, *Kaulf.*	..	..	..	..	..	..	4			
1149. —— falcinellum, *Sw.*	..	..	..	..	..	..	..	..	C	
1150. —— acrostichoides, *Sw.*	..	..	..	..	..	..	4			
1151. —— lepidocaulon, *Hook.*	..	..	..	..	..	..	..	J		
1152. —— Lonchitis, *Sw.*	..	..	..	..	..	..	4	3	2	1
1153. —— mucronatum, *Sw.*	I									
1154. —— Lachenense, *Hook.*	..	..	..	..	..	..	..	3		
1155. —— triangulum, *Sw.*	I									
1156. —— auriculatum, *Sw.*	..	H	..	..	..	..	..	3		
1157. —— ilicifolium, *Don*	..	..	..	..	..	..	..	3		
1158. —— Thomsoni, *Hook.*	..	..	..	..	..	..	..	3		
1159. —— viviparum, *Fée*	I									
1160. —— tridens, *Hook.*	I									
1161. —— acutatum, *Sw.*	10	9	8	7	6	5	4	3	2	1
1162. —— pungens, *Kaulf.*	..	..	..	..	..	5				
1163. —— mohrioides, *Bory*	..	..	M	7						
1164. —— obtusum, *Mett.*	..	M								
1165. —— californicum, *Eaton*	..	..	..	..	..	..	4			
1166. —— Richardi, *Hook.*	..	..	..	..	Z					
1167. —— oculatum, *Hook.*	..	..	..	..	Z					
1168. —— cystostegia, *Hook.*	..	..	..	..	Z					
1169. —— Prescottianum, *Hook.*	..	..	..	..	..	..	..	3		
1170. —— anomalum, *Hook. & Arn.*	..	H								
1171. —— amabile, *Blume*	..	9	..	..	..	..	..	S		
1172. —— tripteron, *Kunze*	..	..	..	..	..	..	..	J		
1173. —— laserpitiifolium, *Mett.*	..	..	..	..	..	..	..	J		
1174. —— varium, *Swartz*	..	..	..	..	..	..	..	C J		
1175. —— capense, *Willd.*	10	..	M	7	6	5				
1176. —— flexum, *Kunze*	..	..	..	7						
1177. —— Seemanni, *Hook.*	10									
1178. —— ascendens, *Hew.*	I									
1179. —— frondosum, *Lowe*	..	..	E	..	..	5	..	..	C	
1180. —— aristatum, *Sw.*	..	9	..	..	A	..	..	3		
1181. —— melanostictum, *Kunze*	10									
1182. —— melanochlamys, *Fée*	I									
1183. —— multifidum, *Mett.*	..	..	..	7						
1184. —— fœniculaceum, *Hook.*	..	..	..	..	..	..	..	3		
1185. —— abbreviatum, *Schrad.*	10									
1186. —— caducum, *Wall.*	..	..	..	..	..	..	..	3		
1187. —— juglandifolium, *Kunze*	10									
1188. —— falcatum, *Sw.*	..	9	..	..	..	5	..	3		
1189. —— meniscioides, *Schrad.*	10									
1190. —— Hookeri, *Baker*	..	M								
1191. —— plantagineum, *Gr.*	10									
1192. —— platanifolium, *Mett.*	..	M								
1193. —— angulatum, *J. Sm.*	..	9								
1194. —— trifoliatum, *Sw.*	10									
1195. —— repandum, *Willd.*	..	M								
1196. —— calcareum, *Presl*	..	M								
1197. —— membranaceum, *Hook.*	..	9								
1198. Nephrodium decursivo-pinnatum, *Baker*	..	..	..	..	..	..	..	C J		
1199. —— pedatum, *Hook.*	I									
1200. —— Braunianum, *Hook.*	10									
1201. —— pusillum, *Baker*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1202. Nephrodium semihastatum, *Hook.*	10									
1203. —— decipiens, *Hook.*	..	..	..	..	..	..	..	C		
1204. —— cuspidatum, *Baker*	..	H	..	..	..	..	..	3		
1205. —— podophyllum, *Hook.*	..	..	..	..	..	..	..	C		
1206. —— Sieboldii, *Hook.*	..	..	..	..	..	..	..	J		
1207. —— hirtipes, *Hook.*	..	9	..	..	..	..	..	3		
1208. —— biauritum, *Hook.*	..	..	M							
1209. —— punctulatum, *Baker*	..	..	W							
1210. —— macrotis, *Hook.*	10									
1211. —— subobliquatum, *Baker*	10									
1212. —— insigne, *Baker*	10									
1213. —— gracilescens, *Hook.*	..	M	..	..	..	..	..	S		
1214. —— chrysolobum, *Fée*	10									
1215. —— patens, *Desv.*	10	P	8	7	..	..	4			
1216. —— macrourum, *Baker*	10									
1217. —— attenuatum, *Baker*	..	M								
1218. —— abruptum, *Baker*	10									
1219. —— invisum, *Baker*	10									
1220. —— immersum, *Hook.*	..	M	..	..	..	..	..	S		
1221. —— Spekei, *Baker*	..	..	8							
1222. —— crinibulbon, *Hook.*	..	..	W							
1223. —— ligulatum, *Hook.*	..	M								
1224. —— obliquatum, *Baker*	..	P								
1225. —— albopunctatum, *Desv.*	..	P	8							
1226. —— calcaratum, *Hook.*	..	9	..	..	..	..	..	S		
1227. —— viscosum, *Baker*	..	M								
1228. —— falciculatum, *Desv.*	10									
1229. —— vestitum, *Baker*	10									
1230. —— Ctenitis, *Baker*	10									
1231. —— crinitum, *Desv.*	..	..	M							
1232. —— velleum, *Baker*	I									
1233. —— Caripense, *Hook.*	10									
1234. —— trichoneuron, *Baker*	I									
1235. —— triste, *Hook.*	10									
1236. —— tetragonum, *Hook.*	10									
1237. —— crassifolium, *Hook.*	..	M								
1238. —— echinatum, *Baker*	..	M								
1239. —— Leprieurii, *Hook.*	10									
1240. —— subfuscum, *Baker*	10									
1241. —— sanctum, *Baker*	10									
1242. —— exiguum, *Hook.*	..	M								
1243. —— canum, *Baker*	..	..	..	..	..	..	..	S		
1244. —— Beddomei, *Baker*	..	9								
1245. —— Noveboracense, *Desv.*	..	..	..	..	..	..	4			
1246. —— conterminum, *Desv.*	10	..	M	7						
1247. —— Kaulfussii, *Hook.*	10									
1248. —— concinnum, *Baker*	10	..	..	7						
1249. —— Sprengelii, *Hook.*	10									
1250. —— prolixum, *Baker*	..	H	M	..	..	..	..	3		
1251. —— limbatum, *Desv.*	I									
1252. —— resino-fœtidum, *Hook.*	10									
1253. —— Sprucei, *Baker*	10									
1254. —— Bergianum, *Baker*	..	..	..	..	..	5				
1255. —— tomentosum, *Baker*	..	..	M	..	..	T				
1256. —— globuliferum, *Hook.*	..	P								
1257. —— velatum, *Hook.*	I									
1258. —— palustre, *Baker*	10									
1259. —— diplazioides, *Hook.*	10									
1260. —— pachyrachis, *Hook.*	10									
1261. —— lonchodes, *Hook.*	I									
1262. —— deltoideum, *Desv.*	I									
1263. —— Thelypteris, *Desv.*	..	..	W	..	Z	5	4	3	2	
1264. —— montanum, *Baker*	..	..	..	..	..	..	..	W	2	1
1265. —— apiciflorum, *Hook.*	..	..	..	..	..	..	..	3		
1266. —— microsorum, *Hook.*	10									
1267. —— griseum, *Baker*	..	H								
1268. —— sagenioides, *Baker*	..	M								
1269. —— syrmaticum, *Baker*	..	9	..	..	..	..	..	S		
1270. —— Filix-mas, *Rich.*	10	9	8	..	..	5	4	3	2	1
1271. —— Preslii, *Baker*	..	M								
1272. —— Goldieanum, *Hook.*	..	..	..	..	..	..	4			
1273. —— marginale, *Mich.*	..	..	..	..	..	..	4			

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1274. Nephrodium lacerum, *Baker*	..	..	..	..	..	..	..	J		
1275. —— erythrosorum, *Hook.*	..	..	..	..	..	..	..	C J		
1276. —— Floridanum, *Hook.*	..	..	..	..	..	..	4			
1277. —— cristatum, *Mich.*	..	..	..	..	..	..	4	..	2	
1278. —— Borneense, *Hook.*	..	M								
1279. —— Salvinii, *Baker*	10									
1280. —— flaccidum, *Hook.*	..	9	..	..	..	..	..	3		
1281. —— Brunonianum, *Hook.*	..	..	..	..	..	..	..	3		
1282. —— barbigerum, *Hook.*	..	..	..	..	..	..	..	3		
1283. —— setosum, *Baker*	..	M								
1284. —— Welwitschii, *Baker*	..	..	W							
1285. —— viridescens, *Baker*	..	..	..	..	..	..	..	J		
1286. —— fragrans, *Rich.*	..	..	..	..	..	..	4	C	..	1
1287. —— rigidum, *Desv.*	..	..	..	..	..	..	4	W	2	
1288. —— spinulosum, *Desv.*	..	..	M	..	..	5	4	3	2	1
1289. —— Eatoni, *Baker*	..	..	..	..	..	..	..	J		
1290. —— mexicanum, *Hook.*	10									
1291. —— sparsum, *Don*	..	9	M	..	..	..	..	S		
1292. —— undulatum, *Baker*	..	H								
1293. —— deparioides, *Hook.*	..	H								
1294. —— Thwaitesii, *Baker*	..	H								
1295. —— sphærocarpum, *Hook.*	10									
1296. —— athamanticum, *Hook.*	..	..	W	..	..	5				
1297. —— inæquale, *Hook.*	..	..	..	..	..	5				
1298. —— Falconeri, *Hook.*	..	..	..	..	..	..	..	3		
1299. —— stipitatum, *Baker*	..	M								
1300. —— hirtum, *Hook.*	I	..	W							
1301. —— squamisetum, *Hook.*	..	..	W							
1302. —— Chinense, *Baker*	..	..	..	..	..	..	..	C J		
1303. —— glabrum, *Baker*	..	P								
1304. —— tenuifolium, *Hook.*	..	P								
1305. —— edentulum, *Baker*	..	M								
1306. —— æmulum, *Baker*	..	..	..	..	..	..	..	..	2	
1307. —— Karwinskianum, *Baker*	10									
1308. —— Napoleonis, *Bory*	..	H								
1309. —— Ascensionis, *Hook.*	..	A								
1310. —— cognatum, *Hook.*	..	H								
1311. —— rubiginosum, *Hook.*	..	P								
1312. —— squamigerum, *H. & A.*	..	P								
1313. —— Bojeri, *Baker*	..	..	M							
1314. —— odoratum, *Baker*	..	M	7	..	..	..	..	3		
1315. —— pubescens, *Desv.*	I									
1316. —— Parishii, *Hook.*	..	M								
1317. —— subquinquefidum, *Hook.*	10	..	W							
1318. —— subsericeum, *Baker*	..	P								
1319. —— decompositum, *R. Br.*	..	P	..	..	6					
1320. —— velutinum, *Hook. fil.*	..	P	..	..	6					
1321. —— recedens, *Hook.*	..	9								
1322. —— Vieillardii, *Baker*	..	P								
1323. —— membranifolium, *Presl*	..	9	M	..	A	..	..	S		
1324. —— Milnei, *Hook.*	..	P								
1325. —— splendens, *Hook.*	..	M	..	..	..	..	..	S		
1326. —— latifrons, *Hook.*	..	P								
1327. —— ferrugineum, *Baker*	..	H								
1328. —— scabrosum, *Baker*	..	H								
1329. —— angustifrons, *Baker*	..	..	..	..	..	..	..	S		
1330. —— Thomsoni, *Hook.*	..	..	..	..	..	..	..	3		
1331. —— oppositum, *Hook.*	..	..	M							
1332. —— intermedium, *Baker*	..	9								
1333. —— lepigerum, *Baker*	..	..	..	..	..	..	..	J		
1334. —— obtusilobum, *Baker*	..	H								
1335. —— Boryanum, *Baker*	..	9	M	..	..	..	..	3		
1336. —— catopteron, *Hook.*	..	..	8	..	..	5				
1337. —— setigerum, *Baker*	..	9	..	..	..	..	..	3		
1338. —— subglandulosum, *Baker*	..	..	M							
1339. —— Grisebachii, *Baker*	I									
1340. —— amplum, *Baker*	10									
1341. —— catocarpum, *Hook*	10									
1342. —— furcatum, *Hook*	10									
1343. —— villosum, *Presl*	10	..	..	7						
1344. —— Trianæ, *Baker*	10									
1345. —— acutum, *Hook.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1346. Nephrodium platypus, *Hook.*	..	9	..	..	..	..	..	S		
1347. —— hispidum, *Hook.*	..	..	M	..	6					
1348. —— denticulatum, *Hook.*	10									
1349. —— davallioides, *Baker*	..	P								
1350. —— effusum, *Baker*	10									
1351. —— Cumingianum, *J. Sm.*	10									
1352. —— Skinneri, *Hook.*	10									
1353. —— Wrightii, *Hook.*	J									
1354. —— scolopendrioides, *Hk.*	I									
1355. —— incisum, *Baker*	10									
1356. —— Otaria, *Baker*	..	9								
1357. —— distans, *Hook.*	..	..	M							
1358. —— unitum, *R. Br.*	10	9	8	..	6	5	..	S	2	
1359. —— sophoroides, *Desv.*	..	..	..	..	..	..	..	C J		
1360. —— pteroides, *J. Sm.*	..	9	..	..	A	..	..	S		
1361. —— extensum, *Hook.*	..	9	..	..	..	..	..	S		
1362. —— Serra, *Desv.*	I									
1363. —— pallidivenium, *Baker*	..	..	8							
1364. —— dissectum, *Desv.*	..	P								
1365. —— procurrens, *Baker*	..	M								
1366. —— longipes, *Moore*	..	M								
1367. —— cucullatum, *Baker*	..	9	M	..	..	..	..	S		
1368. —— Haenkeanum, *Presl*	..	9								
1369. —— hirsutum, *J. Sm.*	..	M								
1370. —— aridum, *Baker*	..	M	..	..	..	..	..	3		
1371. —— venulosum, *Hook.*	..	..	W							
1372. —— glandulosum, *J. Sm.*	..	M	..	..	..	..	..	S		
1373. —— Amboinense, *Presl*	..	M	..	..	..	..	..	S		
1374. —— arbuscula, *Desv.*	..	9	M							
1375. —— abortivum, *J. Sm.*	..	9								
1376. —— refractum, *Hook.*	10									
1377. —— latipinna, *Hook.*	..	M								
1378. —— pennigerum, *Hook.*	..	9	8	..	..	..	..	S		
1379. —— cyatheoides, *Kaulf.*	..	9								
1380. —— asplenioides, *Baker*	I									
1381. —— hispidulum, *Baker*	..	M								
1382. —— molle, *Desv.*	10	9	8	..	6	5	..	S	C	
1383. —— heterocarpon, *Moore*	..	M								
1384. —— stipellatum, *Hook.*	..	M								
1385. —— crinipes, *Hook.*	..	..	..	..	..	..	..	S		
1386. —— venustum, *J. Sm.*	I									
1387. —— ferox, *Moore*	..	M	..	..	..	..	..	S		
1388. —— sagittifolium, *Moore*	..	M								
1389. —— truncatum, *Presl*	..	9	M	..	A	..	..	S		
1390. —— brachyodon, *Hook.*	10	M								
1391. —— Fendleri, *Hook.*	10									
1392. —— dissidens, *Hook.*	I									
1393. —— heterophyllum, *Hook.*	..	M								
1394. —— excellens, *Blume*	..	M								
1395. —— Leuzeanum, *Hook.*	..	9	..	..	..	..	..	S		
1396. —— Singaporianum, *Baker*	..	M								
1397. —— ternatum, *Baker*	..	M						S		
1398. —— vastum, *Baker*	..	M	..	..	..	..	..			
1399. —— melanocaulon, *Baker*	..	M								
1400. —— subtriphyllum, *Baker*	10	9	M							
1401. —— latifolium, *Baker*	10	P	W							
1402. —— Lobbii, *Baker*	..	M								
1403. —— semibipinnatum, *Baker*	..	M								
1404. —— Menyanthidis, *Baker*	..	9								
1405. —— irriguum, *Baker*	..	M						S		
1406. —— polymorphum, *Baker*	..	9	..	..	..	..	..			
1407. —— elatum, *Baker*	10									
1408. —— Pica, *Baker*	..	..	M							
1409. —— Zollingerianum, *Baker*	..	M						S		
1410. —— variolosum, *Baker*	..	M	..	..	..	..	..			
1411. —— irregulare, *Baker*	..	P						S		
1412. —— decurrens, *Baker*	..	9	..	..	..	..	..			
1413. —— siifolium, *Baker*	..	M								
1414. —— pachyphyllum, *Baker*	..	9								
1415. —— Barteri, *Baker*	..	..	W					S		
1416. —— cicutarium, *Baker*	10	9	8	..	..	..	..	S		
1417. —— Griffithii, *Baker*	..	..	..	..	..	..	..			

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1418. *Nephrodium giganteum, Baker*	..	9								
1419. —— *macrophyllum, Baker*	10	M								
1420. *Nephrolepis cordifolia, Baker*	10	9	8	..	A	..	..	S		
1421. —— *exaltata, Schott.*	10	9	8	..	A	..	..	S		
1422. —— **acuta, *Presl***	10	9	8	..	A	5	..	S		
1423. —— **ramosa, *Baker***	..	9	8	..	A					
1424. —— *altescandens, Baker*	..	P	..	7	A					
1425. —— **floccigera, *Moore***	..	M								
1426. —— **davallioides, *Kunze***	..	M								
1427. *Oleandra neriiformis, Cav.*	10	9	W	..	..	..	..	3		
1428. —— **musæfolia, *Kunze***	..	9								
1429. —— *articulata, Cav.*	..	..	8	..	..	5				
1430. —— *nodosa, Presl*	10									
1431. —— *Wallichii, Hook.*	..	..	..	..	..	..	..	3		
1432. —— *Cumingii, J. Sm.*	..	9								
1433. *Fadyenia prolifera, Hook.*	I									
Tribe 11. POLYPODIEÆ.										
1434. *Polypodium cordatum, Hook.*	I									
1435. —— *hastæfolium, Sw.*	I									
1436. —— *flavo-punctatum, Kaulf.*	10									
1437. —— *Sancta-Gabrieli, Hook.*	10									
1438. —— *allœopterum, Kunze*	10									
1439. —— *Tijuccanum, Raddi*	10									
1440. —— *Walkeræ, Hook.*	..	H								
1441. —— *pauciflorum, Hook.*	10									
1442. —— *obtusilobum, Desv.*	..	..	8							
1443. —— *Sieberianum, Kaulf.*	..	..	M							
1444. —— *erubescens, Wall.*	..	M	..	..	..	..	..	3		
1445. —— *appendiculatum, Wall.*	..	..	..	..	..	..	..	S		
1446. —— *auriculatum, Wall.*	..	..	..	..	..	..	..	3		
1447. —— *Germanianum, Baker*	I									
1448. —— *rusticum, Baker*	I									
1449. —— *refulgens, Klotzsch*	10									
1450. —— *rude, Kunze*	10									
1451. —— *decussatum, Linn.*	10									
1452. —— *unisorum, Baker*	..	P								
1453. —— *platylobum, Baker*	10									
1454. —— *fibrillosum, Baker*	10									
1455. —— *macrophylum, Hook.*	10									
1456. —— *pteroideum, Klotzsch*	10									
1457. —— *Phegopteris, Linn.*	..	..	..	..	..	..	4	C J	2	1
1458. —— *distans, Don*	..	9	..	..	..	..	..	3		
1459. —— *obscurum, Hook.*	..	M								
1460. —— *molle, Roxb.*	..	..	H							
1461. —— *caudatum, Kaulf.*	10									
1462. —— *biseriale, Baker*	10									
1463. —— *deflexum, Baker*	10									
1464. —— *hexagonopterum, Mich.*	..	..	..	..	..	..	4			
1465. —— *Hasseltii, Blume*	..	M								
1466. —— *rufescens, Blume*	..	9	W	..	A					
1467. —— *Dryopteris, Linn.*	..	..	..	..	..	..	4	3	2	1
1468. —— *glanduliferum, Liebm.*	10									
1469. —— *drepanum, Hook.*	..	..	..	..	..	..	..	..	C	
1470. —— *polystichoides, Klotzsch*	10									
1471. —— *rigidum, Hook. & Gr.*	10									
1472. —— *Mannianum, Hook.*	..	..	W							
1473. —— *unidentatum, Hook.*	..	P								
1474. —— *Oldhami, Baker*	..	M								
1475. —— *alpestre, Hoppe*	..	..	..	..	..	..	4	..	2	1
1476. —— *Bojeri, Hook.*	..	..	M							
1477. —— *crinale, Hook. & Arn.*	..	P								
1478. —— *asperulum, J. Sm.*	..	M								
1479. —— *aquilinum, Thouars*	..	..	..	..	..	T				
1480. —— *Hillebrandi, Hook.*	..	P								
1481. —— *punctatum, Thunb.*	10	9	8	7	6	T	..	3		
1482. —— *prasinum, Baker*	10									
1483. —— *sandvicense, Hook. & Arn.*	..	P								
1484. —— *connexum, Kaulf.*	10									
1485. —— *splendidum, Kaulf.*	10									
1486. —— *Vogelii, Hook.*	..	..	W							
1487. —— *nigritianum, Baker*	..	..	W							

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1488. Polypodium Keraudrenianum, *Gaud.*	..	9								
1489. —— dubium, *Hook.*	10									
1490. —— simplicifolium, *Hook.*	..	9								
1491. —— debile, *Baker*	..	M								
1492. —— Borneense, *Hook.*	..	M								
1493. —— diversifolium, *Sw.*	10									
1494. —— rubidum, *Hook.*	..	M								
1495. —— pœcilophlebium, *Hook.*	..	..	..	..	A					
1496. —— Kennedyi, *Muell.*	..	..	..	..	A					
1497. —— meniscioides, *Liebm.*	10									
1498. —— urophyllum, *Wall.*	..	9	..	..	..	..	..	S		
1499. —— crenatum, *Sw.*	10									
1500. —— Ghiesbreghtii, *Lind.*	10									
1501. —— faucium, *Liebm.*	10									
1502. —— proliferum, *Presl*	..	9	E	..	..	5	..	S		
1503. —— arthrothrix, *Hook.*	..	..	M							
1504. —— lineatum, *Cole*	..	9	..	..	..	..	..	S		
1505. —— multilineatum, *Wall.*	..	P	..	..	..	..	..	S		
1506. —— stramineum, *Baker*	10									
1507. —— reptans, *Sw.*	10									
1508. —— costatum, *Hook.*	..	P								
1509. —— oppositifolium, *Hook.*	..	..	W							
1510. —— stegnogrammoides, *Baker*	..	P								
1511. —— pennigerum, *Forst.*	..	..	..	..	Z					
1512. —— unitum, *Hook.*	..	..	W	..	..	5				
1513. —— tetragonum, *Sw.*	10									
1514. —— Barberi, *Hook.*	..	M								
1515. —— megalocarpum, *Hook.*	..	M								
1516. —— ferrugineum, *Baker*	..	M								
1517. —— tenerifrons, *Hook.*	..	M								
1518. —— macrodon, *Rein.*	..	9								
1519. —— Cameroonianum, *Hook.*	..	..	W							
1520. —— Bronguiartii, *Bory*	..	M								
1521. —— difforme, *Blume*	..	M								
1522. —— sparsiflorum, *Hook.*	..	..	W							
1523. —— draconopterum, *Hook.*	10									
1524. —— Sprucei, *Hook.*	10									
1525. —— parasiticum, *Mett.*	..	9								
1526. —— Hookeri, *Brack.*	..	9	M	..	A					
1527. —— pseudo-grammitis, *Gaud.*	..	P								
1528. —— ligulatum, *Baker*	..	P								
1529. —— subevenosum, *Baker*	..	M								
1530. —— jungermannioides, *Klotzsch*	10	..	..	7						
1531. —— hirtellum, *Blume*	..	M								
1532. —— hirtum, *Hook.*	..	M								
1533. —— setigerum, *Blume*	..	M								
1534. —— zeylanicum, *Mett.*	..	H								
1535. —— Samoense, *Baker*	..	P								
1536. —— chrysolepis, *Hook.*	10									
1537. —— bisulcatum, *Hook.*	..	M								
1538. —— gramineum, *Sw.*	10	M								
1539. —— Poppigianum, *Mett.*	..	..	..	..	..	5				
1540. —— marginellum, *Sw.*	10	..	H	7	Z	T				
1541. —— australe, *Mett.*	..	P	..							
1542. —— sessilifolium, *Hook.*	..	M								
1543. —— fasciatum, *Mett.*	..	M								
1544. —— Deplanchei, *Baker*	..	P								
1545. —— multifidum, *Bory*	..	..	M							
1546. —— furcatum, *Mett.*	10									
1547. —— barbatulum, *Baker*	..	..	M							
1548. —— Andinum, *Hook.*	10									
1549. —— trichosorum, *Hook.*	10									
1550. —— trifurcatum, *L.*	10									
1551. —— serrulatum, *Mett.*	10	P	8	7						
1552. —— subpinnatifidum, *Blume*	..	9								
1553. —— cucullatum, *Nees*	..	9								
1554. —— subdimidiatum, *Baker*	10									
1555. —— Organense, *Mett.*	10									
1556. —— leucosorum, *Bojer*	..	..	M							
1557. —— villosissimum, *Hook.*	..	..	W							
1558. —— solidum, *Mett.*	..	M								
1559. —— discolor, *Hook.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1560. Polypodium crassifrons, *Baker*	..	P								
1561. —— subserratum, *Hook.*	..	M								
1562. —— Khasyanum, *Hook.*	..	..	..	..	..	..	..	8		
1563. —— inæquale, *Fée*	I									
1564. —— moniliforme, *Lag.*	10									
1565. —— humile, *Mett.*	10									
1566. —— exiguum, *Griseb.*	I									
1567. —— trichomanoides, *Sw.*	10	M	A	7	..	..	..	3		
1568. —— flabelliforme, *Lam.*	10									
1569. —— subtile, *Kunze*	10									
1570. —— delicatulum, *M. & G.*	10									
1571. —— peruvianum, *Desv.*	10									
1572. —— parvulum, *Bory*	..	9	8	..	..	..	..	3		
1573. —— glandulosum, *Hook.*	..	H								
1574. —— jubæforme, *Kaulf.*	10									
1575. —— pilosissimum, *M. & G.*	10									
1576. —— lasiostipes, *Mett.*	..	P								
1577. —— cultratum, *Willd.*	10	..	8							
1578. —— grammitidis, *R. Br.*	..	..	..	..	6					
1579. —— sarmentosum, *Brack.*	..	9								
1580. —— adenophorus, *H. & A.*	10	9								
1581. —— obliquatum, *Blume*	..	9								
1582. —— repandulum, *Mett.*	..	H								
1583. —— subsecundo-dissectum, *Zoll.*	..	M								
1584. —— minutum, *Blume*	..	9								
1585. —— subfalcatum, *Blume*	..	M								
1586. —— decipiens, *Hook.*	10									
1587. —— subsessile, *Baker*	10									
1588. —— farinosum, *Hook.*	10									
1589. —— curvatum, *Sw.*	10									
1590. —— pendulum, *Sw.*	10									
1591. —— suspensum, *L.*	10									
1592. —— melanopus, *Hook. & Gr.*	10									
1593. —— Celebicum, *Blume*	..	9								
1594. —— griseum, *Liebm.*	10									
1595. —— sublanosum, *Hook.*	10									
1596. —— pilipes, *Hook.*	10									
1597. —— macrocarpum, *Presl*	10	..	..	7						
1598. —— Madrense, *J. Sm.*	10									
1599. —— rigescens, *Bory*	10	..	8	7						
1600. —— fuscatum, *Blume*	..	9								
1601. —— decorum, *Brack.*	..	9								
1602. —— blechnoides, *Hook. & Gr.*	..	P	..	..	A					
1603. —— pediculatum, *Baker*	..	M								
1604. —— argyratum, *Bory*	..	..	M							
1605. —— Skinneri, *Hook.*	10									
1606. —— furfuraceum, *Schl.*	10									
1607. —— papillosum, *Blume*	..	M	..	..	..	..	..	J		
1608. —— radicale, *Moritz*	10									
1609. —— pulchrum, *M. & G.*	10									
1610. —— taxifolium, *Linn.*	10									
1611. —— recurvatum, *Kaulf.*	10									
1612. —— pectinatum, *Linn.*	10									
1613. —— Meridense, *Klotzsch*	10									
1614. —— Abitaguæ, *Hook.*	10									
1615. —— Moritzianum, *Link*	10									
1616. —— ellipsoideum, *Fée*	10									
1617. —— Martensii, *Mett.*	10									
1618. —— pellucidum, *Kaulf.*	..	P								
1619. —— vulgare, *Linn.*	10	..	..	..	..	5	4	CJ	2	1
1620. —— clavifer, *Hook.*	..	M								
1621. —— tenuifolium, *H., B. & K.*	10									
1622. —— venulosum, *Blume*	..	M	..	..	..	..	..	J		
1623. —— heteromorphum, *Hook. & Gr.*	10									
1624. —— reclinatum, *Brack.*	10									
1625. —— semiadnatum, *Hook.*	10									
1626. —— dependens, *Baker*	10									
1627. —— alternifolium, *Hook.*	10									
1628. —— sericeolanatum, *Hook.*	10									
1629. —— lanigerum, *Eaton*	10									
1630. —— sporadolepis, *Eaton*	10									
1631. —— plebeium, *Schlecht.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1632. Polypodium Hartwegianum, *Hook.*	10									
1633. —— biauriculatum, *Hook.*	10									
1634. —— peboruleum, *Schlecht*	10									
1635. —— subpetiolatum, *Hook.*	10									
1636. —— suarium, *H., B. & K.*	10									
1637. —— fraternum, *C. & S.*	10									
1638. —— hygrocarpum, *Baker*	10									
1639. —— semihirtum, *Fée*	..	..	..	..	6					
1640. —— hymenophylloides, *Kaulf.*	..	9								
1641. —— salicifolium, *Schlecht.*	10									
1642. —— tenuisectum, *Blume*	..	M								
1643. —— myriophyllum, *Mett.*	10									
1644. —— schillerifolium, *Kaulf.*	10									
1645. —— longisetosum, *Hook.*	10									
1646. —— fimbriatum, *Fée*	1									
1647. —— pruinatum, *Hook.*	10									
1648. —— tomentosum, *Kaulf.*	..	9								
1649. —— athyrioides, *Hook.*	10									
1650. —— mutabile, *Hook.*	10									
1651. —— microphyllum, *Mett.*	10									
1652. —— subfalcatum, *Blume*	..	M								
1653. —— crenatum, *Hook.*	10									
1654. —— Proctorianum, *Kunze*	10									
1655. —— dareiforme, *Hook.*	..	M	..	..	..	..	..	3		
1656. —— subfalcatum, *Blume*	..	M	..	..	..	..	..	3		
1657. —— vaccinifolium, *L. & F.*	10	..	..	7						
1658. —— pilosiloides, *Linn.*	10									
1659. —— commutatum, *Mett.*	..	M								
1660. —— glaucophyllum, *Kunze*	10	..	W							
1661. —— Matthewsii, *Mett.*	10									
1662. —— Nigrianum, *Mett.*	..	..	..	..	..	..	..	J		
1663. —— amoenum, *Wall.*	..	M	..	..	..	..	..	3		
1664. —— tribobum, *Cav.*	..	..	..	7						
1665. —— crassipes, *Thw.*	..	..	..	..	..	5				
1666. —— Calliopsoides, *Kl.*	..	..	..	..	..	..	4			
1667. —— Novaleh, *Hook. & Gr.*	..	..	..	..	..	..	4			
1668. —— patens, *J. Sm.*	10									
1669. —— translucens, *Kunze*	..	..	..	7						
1670. —— lachnopus, *Wall.*	..	..	..	..	..	..	..	3		
1671. —— pubescens, *Hook.*	10									
1672. —— pleiosorum, *Kunze*	10									
1673. —— lasiopus, *Kuhnh.*	10									
1674. —— Catherinæ, *F. & L.*	10									
1675. —— hybreum, *L.*	10									
1676. —— elaeitorphlebium, *Mett.*	10									
1677. —— Chaerophyllum, *Hook.*	10									
1678. —— Sumatranum, *Hook.*	10									
1679. —— plectolepis, *Hook.*	10									
1680. —— decoratum, *Sprng.*	10									
1681. —— pseudotaxifolium, *Thw.*	..	M								
1682. —— subauriculatum, *Blume*	..	9	..	..	A	..	..	3		
1683. —— Vanoossum, *Wall.*	..	M								
1684. —— Kerrhalei, *Mett.*	..	M								
1685. —— attenuatum, *H., B. & K.*	10									
1686. —— meifolium, *Sw.*	10									
1687. —— Guatemalense, *Hook.*	10									
1688. —— alatum, *Kunze*	10									
1689. —— fraxinifolium, *Jacq.*	10									
1690. —— menisciifolium, *L. & F.*	10		E	7	..	5	4			
1691. —— juvenile, *Sw.*	10									
1692. —— hydrogeris, *Kunze*	10									
1693. —— squamatum, *L.*	10									
1694. —— oligolepis, *Hook.*	10						4			
1695. —— aureum, *Linn.*	10		..	..	..	..				
1696. —— decumanum, *Willd.*	10									
1697. —— angustifolium, *Sw.*	10									
1698. —— lucidum, *Beyr.*	10									
1699. —— sphenodes, *Kunze*	10									
1700. —— coarctatum, *Kunze*	10									
1701. —— hastifolium, *Linn.*	10									
1702. —— repens, *Linn.*	10						4			
1703. —— Phyllitidis, *Linn.*	10	..	..	..	..	..				

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1704. Polypodium decurrens, *Raddi*	10									
1705. —— Fendleri, *Eaton*	10									
1706. —— confluens, *R. Br.*	..	..	..	..	A					
1707. —— serpens, *Forst.*	..	P	..	..	6					
1708. —— adnascens, *Sw.*	..	9	8	..	..	..	..	8		
1709. —— acrostichoides, *Forst.*	..	9	..	A						
1710. —— lingua, *Sw.*	..	9	..	..	..	..	..	3		
1711. —— sphærostichum, *Mett.*	..	M								
1712. —— tricuspe, *Sw.*	..	..	..	..	..	..	..	C J		
1713. —— stigmosum, *Sw.*	..	M	..	..	..	..	..	3		
1714. —— subfurfuraceum, *Hook.*	..	..	..	..	..	..	..	3		
1715. —— nummulariæfolium, *Mett.*	..	9	..	..	..	..	..	3		
1716. —— floccigerum, *Mett.*	..	M	..	..	..	..	..	3		
1717. —— fissum, *Baker*	..	9	..	..	..	..	..	3		
1718. —— floccolosum, *Don*	..	..	..	..	..	..	..	3		
1719. —— africanum, *Mett.*	..	..	8	..	..	5				
1720. —— albicans, *Mett.*	..	M								
1721. —— distichocarpum, *Mett.*	..	M								
1722. —— americanum, *Hk.*	10									
1723. —— Gardneri, *Mett.*	..	H								
1724. —— Penangianum, *Hook.*	..	M								
1725. —— Boothii, *Hook*	..	..	..	..	..	..	..	8		
1726. —— splendens, *Hook.*	..	M								
1727. —— subcostatum, *Hook.*	..	M								
1728. —— accedens, *Blume*	..	9								
1729. —— rostratum, *Hook.*	..	..	..	..	..	—	—	3		
1730. —— geminatum, *Schrad.*	10									
1731. —— oodes, *Kunze*	..	M								
1732. —— Schraderi, *Mett.*	..	..	..	..	..	5				
1733. —— Cunninghami, *Hook.*	..	P	..	..	Z					
1734. —— lineare, *Thunb.*	..	9	8	..	..	5	..	3		
1735. —— tenuilore, *Kunze*	..	M								
1736. —— stenophyllum, *Blume*		M								
1737. —— soridens, *Hook.*	..	M								
1738. —— sinuosum, *Wall.*	..	9								
1739. —— longifolium, *Mett.*	..	M								
1740. —— Brownii, *Wickst.*	..	P								
1741. —— superficiale, *Blume*	..	M	..	..	A					
1742. —— Schomburgkianum, *Kunze*	10							3		
1743. —— percussum, *Cav.*	10									
1744. —— lanceolatum, *Linn.*	10	9	8	7	..	5				
1745. —— linearifolium, *Hook.*	..	..	..	..	..	..	..	C J		
1746. —— glabrum, *Mett.*	..	P	..	..	A					
1747. —— angustatum, *Sw.*		9	..	..	A	..	..	8		
1748. —— Samarense, *Mett.*		M								
1749. —— Swartzii, *Baker*	10									
1750. —— zosteræforme, *Wall.*		M								
1751. —— stigmaticum, *Presl*	10									
1752. —— lycopodioides, *L.*	10	9	8	..	..	5				
1753. —— fuscopunctatum, *Hook.*	10									
1754. —— Mackenii, *Baker*	..	..	..	—		6				
1755. —— Lindbergii, *Mett.*	10									
1756. —— persicariæfolium, *Schrad.*	10									
1757. —— normale, *Don*		M	..	..	..	5	..	3		
1758. —— myriocarpum, *Mett.*	..	M								
1759. —— lanceola, *Mett.*	..	P								
1760. —— rhyncophyllum, *Hook.*	..	M	..	—	..	..		8		
1761. —— Griffithianum, *Hook.*					..			3		
1762. —— Melleri, *Baker*	..	..	M							
1763. —— triquetrum, *Blume*		M								
1764. —— saxatile, *Mett.*		M								
1765. —— ovatum, *Wall.*										
1766. —— platyphyllum, *Sw.*		M			..	..	..	3		
1767. —— crassifolium, *L.*	..									
1768. —— membranaceum, *Don*	10	H	..	..	..	..	..	3		
1769. —— heterocarpum, *Blume*	..	9	..	..	..	..	..	3		
1770. —— irioides, *Lam.*	..	9	8	..	A	5	..	8		
1771. —— musæfolium, *Blume*	..	M								
1772. —— hemionitideum, *Wall.*	..	H		..	..	..	..	3		
1773. —— ensatum, *Thunb.*	—	..						1		
1774. —— crispatum, *Hook.*	..									
1775. —— Labrusca, *Hook.*	10	M								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1776. Polypodium Lifrmæ, *Hook.*	10									
1777. —— spectrum, *Kaulf.*	..	9								
1778. —— hastatum, *Thunb.*	..	..	..	..	..	..	..	C J		
1779. —— pteropus, *Blume*	..	9	..	..	..	..	..	S		
1780. —— Lepcha, *Hook.*	..	9								
1781. —— Wallichii, *R. Br.*	..	..	..	..	..	..	..	S		
1782. —— Lobbianum, *Hook.*	..	M								
1783. —— heracleum, *Kunze*	10									
1784. —— tripinnatum, *Don*	..	H	..	..	..	..	..	3		
1785. —— subcordatum, *Hook.*	..	..	..	..	..	..	..	3		
1786. —— incurvatum, *Blume*	..	M								
1787. —— angustum, *Mett.*	10									
1788. —— insigne, *Blume*	..	M								
1789. —— pustulatum, *Forst.*	..	A	..	..	A					
1790. —— Billardieri, *R. Br.*	..	P	..	..	A					
1791. —— glycyrrhiza, *L.*	..	9	8	..	..	5	..	C J		
1792. —— nigrescens, *Blume*	..	9	..	..	..	..	..	S		
1793. —— affine, *Blume*	..	M								
1794. —— Powellii, *Baker*	..	P								
1795. —— dubium, *Wall.*	..	9	..	..	..	..	..	3		
1796. —— heterolepton, *Blume*	..	M								
1797. —— elatum, *Hook.*	..	P								
1798. —— glaucum, *Kunze*	..	M								
1799. —— leucolepis, *Kze*	..	M								
1800. —— dentipes, *Hook.*	..	..	..	..	..	..	..	3		
1801. —— longissimum, *Blume*	..	9	..	..	..	..	..	S		
1802. —— Heracleum, *Kunze*	..	M								
1803. —— Meyenianum, *Schott*	..	M								
1804. —— conjugatum, *Linn.*	..	M	..	..	..	..	..	S		
1805. —— Fortunei, *Kunze*	..	..	..	..	..	..	..	C		
1806. —— splendens, *Hook.*	..	M								
1807. —— proliferum, *Wall.*	..	M	W	..	..	..	..	3		
1808. —— Wilkesii, *Berg*	..	..	M							
1809. —— rivale, *Mett.*	..	..	..	..	..	..	..	S		
1810. —— quercifolium, *L.*	..	9	..	..	A	..	..	S		
1811. —— Linnæi, *Berg*	..	9								
1812. —— rigidulum, *Sw.*	..	9	..	..	A					
1813. —— palmense, *Blume*	..	M								
1814. —— [illegible], *Don*	..	..	..	..	..	..	..	3	3	3
1815. —— Lehmanni, *Mett.*	..	..	..	..	..	..	..			
1816. —— blumeanum, *Hook.*	..	..	..	..	..	..	..			
1817. —— heterolepis, *Hook.*	..	..	..	..	..	..	..			
1818. —— allosquamosum, *Blume*	..	M								
Tribe 12. Grammitideæ.										
1819. Jamesonia imbricata, *H. & G.*	10									
1820. Notochlæna Rawsoni, *P. & R.*	..	..	..	..	..	5				
1821. —— sinuata, *Kaulf.*	10	..	..	..	..	..	4			
1822. —— hemionitis, *Hook.*	10	..								
1823. —— lanuginosa, *Don*	..	A	W	..	A	..	..	W	2	
1824. —— Hippocrepidii, *Baker*	10									
1825. —— tomentosa, *Kunze*	..	..	W	..	..	5				
1826. —— Aschenborniana, *Endl.*	10									
1827. —— aphrosa, *Baker*	10	..	..	..	..		3	2		
1828. —— Marantæ, *R. Br.*	..	..	..	..	..	5				
1829. —— Eckloniana, *Kunze*		..	..	..	..					
1830. —— mollis, *Kunze*	10	..	..	..	..					
1831. —— Swallii, *Hook.*	..	A								
1832. —— hirsuta, *Don*	..	9								
1833. —— dubia, *R. Br.*	..	P	..	..	6					
1834. —— hypolepis, *Kunze*	..	..	..	..						
1835. —— Pohliana, *Kunze*	10									
1836. —— subglabra, *Fée*	10					5				
1837. —— Buchtienii, *Luther*	..	..	..	..	..					
1838. —— tenera, *Gill.*	10	..	..	..						
1839. —— subcomposita, *R. Br.*	1									
1840. —— ethela, *Hook.*	10						4			
1841. —— subglauca, *J. Sm.*	10	..	..	..	..	..				
1842. —— flavens, *Mapp.*	10									
1843. —— nivea, *Don*	10									
1844. —— Chilensis, *Hook.*	..	..	..	..	..	..	4			
1845. —— dealbata, *Kunze*	..	..	..	..	..	..				

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1846. Notochlæna Fendleri, *Kunze*	..	..	..	..	..	..	4			
1847. Monogramme dareæcarpa, *Hook.*	..	M								
1848. —— graminea, *Schk.*	..	..	M	..	..	5				
1849. —— subfalcata, *Hook.*	..	P								
1850. —— trichoidea, *J. Sm.*	..	M								
1851. —— rostrata, *Hook.*	10									
1852. —— Junghuhnii, *Hook.*	..	9								
1853. —— graminoides, *Baker*	10	..	H	7						
1854. —— seminuda, *Baker*	10									
1855. —— immersa, *Fée*	10									
1856. Gymnogramma pilosa, *M. & G.*	10									
1857. —— asplenioides, *Klf.*	10									
1858. —— Totta, *Schlecht.*	..	9	8	..	..	5	..	3	C	
1859. —— villosa, *Link*	10									
1860. —— polypodioides, *Spr.*	10									
1861. —— diplazioides, *Desv.*	10									
1862. —— grandis, *Baker*	10									
1863. —— gracilis, *Heward*	I									
1864. —— aurita, *Hook.*	..	..	..	..	..	..	..	3		
1865. —— decurrenti-alata, *Hook.*	..	..	..	..	..	..	..	J		
1866. —— opaca, *Spreng.*	M	..	..	..	..	..	..	S		
1867. —— ambigua, *Hook.*	..	M								
1868. —— aspidioides, *Hook.*	..	M	..	..	..	..	..	3		
1869. —— reniformis, *Mart.*	10									
1870. —— marginata, *Mett.*	..	P								
1871. —— pumila, *Spreng.*	10									
1872. —— Muelleri, *Hook.*	..	..	..	..	A					
1873. —— vestita, *Hook.*	..	..	..	..	..	..	..	3		
1874. —— rufa, *Desv.*	10									
1875. —— cordata, *Schlecht.*	..	..	W	..	..	5				
1876. —— Pozoi, *Kunze*	..	..	..	7	6	..	..	..	2	
1877. —— tomentosa, *Desv.*	10									
1878. —— angustifrons, *Baker*	10									
1879. —— hirsutula, *Mett.*	10									
1880. —— Karstenii, *Mett.*	10									
1881. —— incisa, *M. & L.*	10									
1882. —— mohriæformis, *Mett.*	10									
1883. —— Ottonis, *Klotzsch*	10									
1884. —— Lindigii, *Mett.*	10									
1885. —— decipiens, *Mett.*	..	P								
1886. —— ferruginea, *Kunze*	10									
1887. —— Haughtoni, *Hook.*	..	..	H							
1888. —— Hookeri, *J. Sm.*	10									
1889. —— javanica, *Blume*	..	9	..	..	..	..	..	3		
1890. —— Schomburgkiana, *Kunze*	10									
1891. —— aureonitens, *Hook.*	10									
1892. —— Matthewsii, *Hook.*	10									
1893. —— Warcewiczii, *Mett.*	10									
1894. —— cheilanthoides, *Klf.*	..	..	M	..	..	T				
1895. —— flabellata, *Hook.*	10									
1896. —— myriophylla, *Sw.*	10									
1897. —— pedata, *Kaulf.*	10									
1898. —— leptophylla, *Desv.*	10	I	E	..	6	..	..	W	2	
1899. —— Ascensionis, *Hook.*	..	..	A							
1900. —— chærophylla, *Desv.*	10	..	..	7						
1901. —— microphylla, *Hook.*	..	..	..	..	..	..	..	8		
1902. —— hirta, *Desv.*	10									
1903. —— flexuosa, *Desv.*	10									
1904. —— Pearcei, *Moore*	10									
1905. —— trifoliata, *Desv.*	10	..	..	7						
1906. —— triangularis, *Kaulf.*	10	..	..	..	..	..	4			
1907. —— tartarea, *Desv.*	10	..	..	..	..	5				
1908. —— calomelanos, *Kaulf.*	10	P	W							
1909. —— pulchella, *Lind.*	10									
1910. —— sulphurea, *Desv.*	I									
1911. —— rosea, *Desv.*	..	..	8	..	..	5				
1912. —— borneensis, *Hook.*	..	M								
1913. —— cartilagidens, *Baker*	..	M								
1914. —— obtusifolia, *Hook.*	..	M								
1915. —— Lobbiana, *Hook.*	..	M								
1916. —— vittæformis, *Hook.*	..	M								
1917. —— Wallichii, *Hook.*	..	M								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1918. Gymnogramma alismæfolia, *Hook.*	..	M								
1919. —— quinata, *Hook.*	..	9								
1920. —— lanceolata, *Hook.*	..	9	8	..	..	5	..	S		
1921. —— mexicana, *Baker*	10									
1922. —— elongata, *Hook.*	10	..	..	7						
1923. —— involuta, *Don*	..	9	..	..	..	..	..	3		
1924. —— membranacea, *Hook.*	..	M								
1925. —— Wrightii, *Hook.*	..	M	..	..	..	..	..	J		
1926. —— regularis, *Baker*	..	M								
1927. —— macrophylla, *Hook.*	..	9								
1928. —— spuria, *Baker*	..	M								
1929. —— Feei, *Hook.*	..	M								
1930. —— heterocarpa, *Blume*	..	M								
1931. —— Hamiltoniana, *Wall.*	..	..	..	..	..	..	..	S		
1932. —— caudiformis, *Hook.*	..	9								
1933. —— elliptica, *Baker*	..	9	..	..	A	..	..	3		
1934. —— pinnata, *Hook.*	..	9	..	..	A					
1935. —— japonica, *Desv.*	..	M	..	..	..	..	..	J		
1936. —— podophylla, *Hook.*	10	..	..	..	..	..	4			
1937. Brainea insignis, *Hook.*	..	M	..	..	..	..	..	S		
1938. Meniscium simplex, *Hook.*	..	M	..	..	..	..	..	S		
1939. —— giganteum, *Mett.*	10									
1940. —— triphyllum, *Sw.*	..	9	..	..	..	..	..	S		
1941. —— Thwaitesii, *Hook.*	..	H								
1942. —— pauciflorum, *Hook.*	..	..	W							
1943. —— salicifolium, *Wall.*	..	M								
1944. —— angustifolium, *Willd.*	10									
1945. —— serratum, *Cav.*	10									
1946. —— reticulatum, *Sw.*	10									
1947. Antrophyum lineatum, *Kaulf.*	10									
1948. —— subfalcatum, *Brack.*	..	9								
1949. —— immersum, *Mett.*	..	..	M							
1950. —— coriaceum, *Wall.*	..	M	..	..	..	..	..	S		
1951. —— plantagineum, *Kaulf.*	..	9	..	..	..	..	..	S		
1952. —— Cumingii, *Fée*	..	M								
1953. —— reticulatum, *Kaulf.*	..	9	..	..	A	..	..	S		
1954. —— semicostatum, *Blume*	..	9								
1955. —— ensiforme, *Hook.*	10									
1956. —— lanceolatum, *Kaulf.*	10									
1957. —— subsessile, *Kunze*	10									
1958. —— Cayennense, *Kaulf.*	10									
1959. —— latifolium, *Blume*	...	M								
1960. —— Mannianum, *Hook.*	..	..	W							
1961. —— Boryanum, *Kaulf.*	..	..	M							
1962. —— giganteum, *Bory*	..	..	M							
1963. Vittaria elongata, *Sw.*	..	9	8	..	A	..	..	S		
1964. —— scabrida, *Klotzsch*	10									
1965. —— falcata, *Kunze*	..	9								
1966. —— Gardneriana, *Fée*	10									
1967. —— stipitata, *Kunze*	10									
1968. —— stricta, *Carm.*	..	..	..	..	..	T				
1979. —— lineata, *Sw.*	10	M	8	..	..	5	4	3		
1970. —— scolopendrina, *Thw.*	..	9	E							
1971. Tænitis obtusa, *Hook.*	..	M								
1972. —— angustifolia, *R. Br.*	10									
1973. —— furcata, *Willd.*	10									
1974. —— lanceolata, *R. Br.*	10									
1975. —— blechnoides, *Sw.*	..	M						S		
1976. Drymoglossum carnosum, *Hook.*	..	M	..	..	..	..	..	S		
1977. —— piloselloides, *Presl*	..	9	..	..	..	..	..			
1978. —— rigidum, *Hook.*	..	M								
1979. Hemionitis lanceolata, *Hook.*	..	P								
1980. —— cordata, *Roxb.*	..	9								
1981. —— palmata, *L.*	10									
1982. —— hederæfolia, *J. Sm.*	10									
1983. —— pinnatifida, *Baker*	10									
1984. —— pinnata, *J. Sm.*	I							S		
1985. —— Griffithii, *Hook. fil. & Th.*	..	M	..	..	..	..	..			
1986. —— citrifolia, *Hook.*	10									
Tribe 13. ACROSTICHEÆ.										
1987. Acrostichum petiolosum, *Desv.*	10									

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
1988. Acrostichum tambillense, *Hook.*	10									
1989. —— micradenium, *Fée*	..	9								
1990. —— simplex, *Sw.*	10									
1991. —— nigrescens, *Hook.*	10									
1992. —— leptophyllum, *Fée*	10									
1993. —— conforme, *Sw.*	10	9	8	7	..	5	..	3		
1994. —— Wrightii, *Mett.*	I									
1995. —— flaccidum, *Fée*	10									
1996. —— Burchellii, *Baker*	10									
1997. —— Norrisii, *Hook.*	..	M								
1998. —— Schlimense, *Fée*	10									
1999. —— palustre, *Hook.*	..	..	W							
2000. —— stenopteris, *Klotzsch*	10									
2001. —— Herminieri, *Bory*	I									
2002. —— lingua, *Raddi*	10									
2003. —— luridum, *Fée*	10									
2004. —— Sieberi, *Hook. & Gr.*	..	..	8							
2005. —— latifolium, *Sw.*	10	M								
2006. —— stramineum, *Mett.*	10									
2007. —— melanopus, *Kunze*	10									
2008. —— hybridum, *Bory*	10	..	8	..	..	5				
2009. —— decurrens, *Desv.*	..	M								
2010. —— decoratum, *Kunze*	10									
2011. —— Feei, *Bory*	10									
2012. —— cardiophyllum, *Hook.*	10									
2013. —— squamipes, *Hook.*	10									
2014. —— Lindeni, *Bory*	10									
2015. —— squamosum, *Klotzsch*	10									
2016. —— Lloense, *Hook.*	10									
2017. —— heteromorphum, *Klotzsch*	10									
2018. —— Huacsaro, *Ruiz*	10									
2019. —— Gardnerianum, *Fée*	10									
2020. —— alpestre, *Gardn.*	10									
2021. —— lineare, *Fée*	10	..	M							
2022. —— Aubertii, *Desv.*	10	..	8	..	..	5				
2023. —— dimorphum, *Hook. & Gr.*	..	..	H							
2024. —— viscosum, *Sw.*	10	9	8	..	..	..	..	3		
2025. —— ciliatum, *Presl*	10									
2026. —— pilosum, *H., B. & K.*	10									
2027. —— Samoense, *Baker*	..	P								
2028. —— apodum, *Kaulf.*	10									
2029. —— scolopendrifolium, *Raddi*	10									
2030. —— Cumingii, *Fée*	..	M								
2031. —— Boryanum, *Fée*	I									
2032. —— ovatum, *Hook*	10									
2033. —— procurrens, *Mett.*	I									
2034. —— spathulatum, *Bory*	10	H	M	..	..	5				
2035. —— Matthewsii, *Fée*	10									
2036. —— acrocarpum, *Mart.*	10									
2037. —— succisæfolium, *Thouars*	..	..	M	..	..	T				
2038. —— cinnamomeum, *Baker*	..	..	W							
2039. —— lepidotum, *Willd.*	10									
2040. —— strictum, *Raddi*	10									
2041. —— villosum, *Sw.*	10	..	W							
2042. —— tectum, *Willd.*	10									
2043. —— Bellermannianum, *Klotzsch*	10									
2044. —— muscosum, *Sw.*	10									
2045. —— obductum, *Kaulf.*	10	..	M							
2046. —— auricomum, *Kunze*	10									
2047. —— tomentosum, *Bory*	..	..	M							
2048. —— cuspidatum, *Willd.*	10									
2049. —— perelegans, *Fée*	10									
2050. —— Sprucei, *Baker*	10									
2051. —— squamosum, *Sw.*	10	9	8	..	..	..	..	..	C	
2052. —— sorbifolium, *L.*	10	9	8							
2053. —— decrescens, *Baker*	..	..	W							
2054. —— scandens, *J. Sm.*	..	9	..	..	A	..	..	S		
2055. —— laurifolium, *Hook.*	..	9								
2056. —— tenuifolium, *Baker*	..	..	M	..	..	5				
2057. —— bifurcatum, *Sw.*	..	..	H							
2058. —— articulatum, *Hook.*	..	M								
2059. —— Wilkesianum, *Hook.*	..	P								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
2060. Acrostichum apiifolium, *Hook.*	..	M								
2061. —— plumbicaule, *Baker*	10									
2062. —— fractiseriale, *Baker*	10									
2063. —— aspidioides, *Baker*	I									
2064. —— pubens, *Baker*	10									
2065. —— acuminatum, *Hook.*	10									
2066. —— caudatum, *Hook.*	10									
2067. —— osmundaceum, *Hook.*	10									
2068. —— canaliculatum, *Hook.*	10									
2069. —— Lechlerianum, *Hook.*	10									
2070. —— appendiculatum, *Willd.*	..	9	..	..	..	..	..	S		
2071. —— flabellatum, *H., B. & K.*	10									
2072. —— peltatum, *Sw.*	10									
2073. —— funiculaceum, *Hook.*	10									
2074. —— subdiaphanum, *Hook. & Gr.*	..	..	H							
2075. —— gorgoneum, *Kaulf.*	..	P								
2076. —— cervinum, *Sw.*	10									
2077. —— auritum, *Sw.*	..	9								
2078. —— Cænopteris, *Kunze*	10									
2079. —— Linnæanum, *Hook.*	..	M								
2080. —— Gaboonense, *Hook.*	..	..	W							
2081. —— variabile, *Hook.*	..	9	..	..	..	..	..	S		
2082. —— oligarchicum, *Baker*	10									
2083. —— quercifolium, *Retz.*	..	9								
2084. —— Harlandii, *Hook.*	..	M								
2085. —— taccæfolium, *Hook.*	..	M								
2086. —— flagelliferum, *Wall.*	..	9	..	..	..	..	..	S		
2087. —— repandum, *Blume*	..	9	S	..	A					
2088. —— punctulatum, *Linn.*	..	..	8							
2089. —— subrepandum, *Hook.*	..	M								
2090. —— alienum, *Sw.*	10									
2091. —— nicotianæfolium, *Sw.*	10									
2092. —— Preslianum, *Hook.*	..	9								
2093. —— virens, *Wall.*	..	9	W	..	..	..	..	S		
2094. —— minus, *Mett.*	..	M	..	..	..	..	..	S		
2095. —— lanceolatum, *Hook.*	..	9								
2096. —— axillare, *Cav.*	..	9	..	..	..	..	..	S		
2097. —— aureonitens, *Hook.*	10									
2098. —— reticulatum, *Kaulf.*	..	P								
2099. —— pachyphyllum, *Kunze*	10									
2100. —— crinitum, *Linn.*	10									
2101. —— bicuspe, *Hook.*	..	9								
2102. —— tricuspe, *Hook.*	..	..	..	..	..	..	..	S		
2103. —— fluviatile, *Hook.*	..	..	W							
2104. —— pandurifolium, *Hook.*	10									
2105. —— Heudelotii, *Hook.*	..	..	8							
2106. —— salicinum, *Hook.*	..	..	W							
2107. —— semicordatum, *Baker*	..	H								
2108. —— Blumeanum, *Hook.*	..	9								
2109. —— Raddianum, *Kunze*	10									
2110. —— serratifolium, *Mert.*	10									
2111. —— præstantissimum, *Bory*	10									
2112. —— aureum, *Linn.*	10	9	8	..	A	5	4			
2113. —— polyphyllum, *Hook.*	..	P								
2114. —— spicatum, *Linn.*	..	9	M	..	A	..	..	3		
2115. —— platyrhynchos, *Hook.*	..	M								
2116. —— rigidum, *Wall.*	..	M								
2117. —— dryopteroides, *Hook.*	..	9								
2118. Platycerium alcicorne, *Desv.*	10	..	M	..	A					
2119. —— æthiopicum, *Hook.*	..	..	7							
2120. —— grande, *J. Sm.*	..	M	..	..	A					
2121. —— Wallichii, *Hook.*	..	M								
2122. —— biforme, *Blume*	..	M								
SUBORDER III. OSMUNDACEÆ.										
2123. Osmunda Javanica, *Blume*	..	9	..	..	..	..	..	C		
2124. —— Claytoniana, *L.*	..	..	..	..	..	..	4	3		
2125. —— cinnamomea, *L.*	10	..	..	..	..	..	4	CJ		
2126. —— bipinnata, *Hook.*	..	M				5	4	3	2	
2127. —— regalis, *Linn.*	10	9	8	..	..	5				
2128. Todea barbara, *Moore*	..	..	..	..	6					
2129. —— Fraseri, *Hook. & Gr.*	..	P	..	..	A					

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
2130. Todea hymenophylloides, *R. & L.*	..	..	..	..	Z					
2131. —— superba, *Cole*	..	..	..	..	Z					
SUBORDER IV. SCHIZÆACEÆ.										
2132. Schizæa australis, *Gaud.*	..	..	..	7	N					
2133. —— pusilla, *Pursh*	..	..	..	..	..	..	4			
2134. —— Malaccana, *Baker*	..	M								
2135. —— tenella, *Kaulf*	..	..	..	..	..	5				
2136. —— fistulosa, *Lab.*	..	P	..	7	6					
2137. —— robusta, *Baker*	..	P								
2138. —— pectinata, *Smith*	..	..	..	..	..	5				
2139. —— incurvata, *Schk.*	10									
2140. —— bifida, *Sw.*	..	..	..	..	6					
2141. —— rupestris, *R. Br.*	..	..	..	..	A					
2142. —— Fluminensis, *Miers*	10									
2143. —— Sprucei, *Hook.*	10									
2144. —— dichotoma, *Sw.*	10	9	M	..	6					
2145. —— elegans, *Sw.*	10									
2146. —— pennula, *Sw.*	10	P								
2147. —— digitata, *Wall.*	..	9	..	..	..	..	..	..	S	
2148. Anemia Gardneri, *Hook.*	10									
2149. —— filiformis, *Presl*	10									
2150. —— oblongifolia, *Sw.*	10									
2151. —— Dregeana, *Kunze*	..	..	..	..	..	5				
2152. —— rotundifolia, *Schrad.*	10									
2153. —— caudata, *Kaulf.*	10									
2154. —— Mandioccana, *Raddi*	10									
2155. —— collina, *Raddi*	10									
2156. —— glareosa, *Gardn.*	10									
2157. —— Breuteliana, *Presl*	10									
2158. —— Langsdorffiana, *Presl*	10									
2159. —— Mexicana, *Klotzsch*	10	..	..	..	..	..	4			
2160. —— hirsuta, *Sw.*	10									
2161. —— tomentosa, *Sw.*	10									
2162. —— trichorhiza, *Gardn.*	10									
2163. —— rutæfolia, *Mart.*	10									
2164. —— adiantifolia, *Sw.*	10	..	..	..	..	..	4			
2165. —— cuneata, *Kunze*	I									
2166. —— Tweediana, *Hook.*	10									
2167. —— Schraderiana, *Mart.*	10									
2168. —— Phyllitidis, *Sw.*	10									
2169. —— aurita, *Sw.*	I									
2170. —— Wrightii, *Baker*	I									
2171. —— bipinnata, *Moore*	I									
2172. —— dichotoma, *Gardn.*	10									
2173. —— millefolia, *Gardn.*	10									
2174. Mohria caffrorum, *Desv.*	..	..	M	..	..	5				
2175. Trochopteris elegans, *Gardn.*	10									
2176. Lygodium palmatum, *Sw.*	..	..	..	..	..	..	4			
2177. —— dichotomum, *Sw.*	..	9	..	..	..	..	..	C		
2178. —— digitatum, *Eaton*	10									
2179. —— semihastatum, *Desv.*	..	M								
2180. —— articulatum, *Rich.*	..	..	..	..	Z					
2181. —— trifureatum, *Baker*	..	P								
2182. —— scandens, *Sw.*	10	9	W	..	A	..	..	3		
2183. —— venustum, *Sw.*	10	..	..	7						
2184. —— volubile, *Sw.*	10									
2185. —— pinnatifidum, *Sw.*	..	9	W	..	..	..	..	S		
2186. —— polystachyum, *Wall.*	..	M								
2187. —— subalatum, *Bojer*	..	..	M							
2188. —— japonicum, *Sw.*	..	9	..	..	..	..	..	S		
2189. —— heterodoxum, *Kunze*	10									
2190. —— reticulatum, *Schk.*	..	P								
2191. —— lanceolatum, *Desv.*	..	..	M							
SUBORDER V. MARATTIACEÆ.										
2192. Angiopteris evecta, *Hoffm.*	..	9	M	..	A	..	..	S		
2193. Marattia fraxinea, *Sm.*	..	9	7	..	6	5				
2194. —— attenuata, *Lab.*	..	P								
2195. —— cicutæfolia, *Kaulf.*	10									
2196. —— laxa, *Kunze*	10									
2197. —— Douglasii, *Baker*	..	P								

	Torrid zone.			South Temperate zone.			North Temperate zone.			Frigid zone.
2198. Marattia alata, *Sm.*	10									
2199. —— Kaulfussii, *J. Sm.*	10									
2200. Danæa simplicifolia, *Rudge*	10									
2201. —— trifoliata, *Reich.*	10									
2202. —— trichomanoides, *Spr.*	10									
2203. —— Leprieurii, *Kunze*	10									
2204. —— humilis, *Moore*	10									
2205. —— alata, *Smith*	I									
2206. —— Augustii, *Karst.*	10									
2207. —— Moritziana, *Presl*	10									
2208. —— stenophylla, *Kunze*	I									
2209. —— elliptica, *Smith*	10									
2210. —— nodosa, *Smith*	10									
2211. Kaulfussia æsculifolia, *Bl.*	..	M	..	..	..	..	..	S		
SUBORDER VI. OPHIOGLOSSACEÆ.										
2212. Ophioglossum lusitanicum, *L.*	..	H	W	..	6	..	..	W	2	
2213. —— rubellum, *Welw.*	..	..	W							
2214. —— bulbosum, *Mich.*	10	..	..	7	..	T	4			
2215. —— nudicaule, *Kunze*	10	9	W	7	..	..	4			
2216. —— vulgatum, *L.*	10	9	8	..	6	5	4	3	2	1
2217. —— reticulatum, *L.*	10	9	8	..	..	5	..	S		
2218. —— intermedium, *Hook.*	..	M								
2219. —— pendulum, *L.*	..	9	M	..	A	..	..	S		
2220. —— palmatum, *L.*	10	..	M							
2221. —— Bergianum, *Schl.*	..	..	..	..	..	5				
2222. Helminthostachys zeylanica, *Hook.*	..	9	..	..	A	..	..	S		
2223. Botrychium simplex, *Hitch*	..	..	..	..	..	..	4	..	2	
2224. —— rutaceum, *Sw.*	..	..	..	..	..	..	4	C	2	
2225. —— Lunaria, *Sw.*	..	..	..	7	6	..	4	3	2	1
2226. —— ternatum, *Sw.*	10	..	..	..	6	..	4	3	2	1
2227. —— daucifolium, *Wall.*	..	9	..	..	..	..	..	3		
2228. —— virginicum, *Sw.*	10	H	..	..	..	..	4	3	2	
Total	946	863	346	118	212	153	114	413	81	26
Species peculiar to the district	757	477	127	32	74	22	37	114	12	0
Percentage of total number of species which are peculiar	80	55	36	28	34	14	32	27	15	0

Going through the districts one by one, I will next endeavour to point out the principal characteristics which their fern-floras present.

1. *Arctic Zone.*—The Arctic region yields in all only 26 species, about one per cent. of the total number. Not one of them is peculiar to it, and no species can even be said to have its headquarters here. The two ferns most preeminently northern in their range are *Asplenium crenatum* and *Nephrodium fragrans*; and both are widely diffused in the north temperate zone. Fifteen species inhabit Arctic America, all of which, with one exception, are Arctic-European also; and, in the Arctic zone, the other eleven are confined to Europe. With one exception, *Nephrodium fragrans*, all the Arctic ferns have a wide range in temperate Europe; and only two, the species which have just been mentioned, are not British.

2. *Temperate Europe and Africa.*—Of all the temperate regions, this has the smallest fern-flora, and considerably the smallest number of peculiar species. The total number of species which it yields is 81, four per cent. of the Order. Taking, first, those of Europe, which are 67 in number, we may divide them into four classes, viz.:—1st, species almost universally, or at any rate widely, diffused through central Europe; the number of these may be put at 22; 2nd, species widely diffused through the centre of the con-

tinent, but restricted to mountainous tracts, say 12; and, 3rd, species preeminently south-western, restricted to the vicinity of the Mediterranean and Atlantic, say 18. This leaves fifteen species, only one of which, *Asplenium crenatum*, is specially northern in its range; the other fourteen are scattered, more or less sparingly, through Central Europe, not a single one being preeminently eastern or having its head quarters in Asia and coming a little within European bounds. The only widely diffused Central-European species which we do not possess in Britain are, with some doubt as to the last, *Onoclea germanica*, *Cystopteris alpina*, *Asplenium fissum*, and *Botrychium rutaceum*. On the other hand, eight of the south-western species enter into the British list,—one of them, *Hymenophyllum Tunbridgense*, being widely dispersed, but two not reaching further north than the Channel Islands. Twelve species grow in the West African Islands which are not European. These are:—

*Dicksonia Culcita.	*Aspidium falcinellum.
Adiantum reniforme.	—— frondosum.
*Cheilanthes pulchella.	Nephrodium molle.
Asplenium monanthemum.	*Polypodium drepanum.
—— furcatum.	Gymnogramma Totta.
—— umbrosum.	Acrostichum squamosum.

The four marked with an asterisk are quite peculiar to these islands, the *Dicksonia* being much the most distinctly marked specific type which this second district yields. Of the others, the *Adiantum* is Mauritian (but the Mauritian plant is a well-marked variety), and *Aspidium frondosum*, long supposed to be peculiar, has been detected recently in Natal. The other six are all widely diffused tropical and subtropical species, all being met with in tropical Africa, so that in the fern-flora of these islands we cannot find any trace of an American affinity. The number of Canarian species is 31, of Azorean 25. The species common to the islands and Europe are all of the south-western or general European type, the 12 montane European species being entirely absent. To the European list we get only two species added in North Africa, *Nephrodium unitum* and *Actiniopteris radiata*—a very significant fact in illustration of the connexion between climate and fern-geography, as we shall see best when we come to contrast this addition of only two species for an area of between two and three millions of square miles of subtropical country, with the large number of species which are added in subtropical Asia to those that grow further north. Both of these are widely dispersed tropical species. The number of species peculiar to continental Europe is only six—*Asplenium germanicum*, *Heufleri*, *Petrarchæ*, *fissum*, and *Seelosii*, and *Cheilanthes hispanica*; *Nephrodium æmulum* is confined to Britain, the Canaries, and Madeira, *Davallia canariensis* to the West African islands and Spanish peninsula; of species not quite, but nearly peculiar to this second district, *Nephrodium montanum* extends only into Lapland and Georgia, and *Asplenium Hemionitis* to the Cape Verde Islands.

3. *Temperate Asia.*—It is here, as compared with all the other temperate districts, that the fern-flora reaches its maximum development. This district yields 413 species, 18 per cent. of the total number, more than half the whole number of species that grow anywhere in temperate regions, twice as many as grow in any other temperate district,

more than five times as many as we possess in Europe; and of these one out of between every three and four is peculiar to it. But a large proportion of the species, and nearly all the peculiar ones, are concentrated in a small part of its area, in Japan, East China, and the Himalayas—a tract not embracing more than a tenth part of the fourteen million square miles which this district includes. In broad terms we may say that the northern half of this district belongs to Asiatic Russia. The total number of Russian species, European, Asiatic, and American added together, is only 49. Taking the provinces of Asiatic Russia as defined in Ledebour's Flora, and reckoning the species according to the Synopsis-standard, we find they only yield ferns as follows :—

Caucasian provinces . .	28	Davurian Siberia . . .	14
Altaic Siberia . . .	20	Eastern Siberia . . .	8
Baikalian Siberia . . .	22	Kamschatka	17
Uralian Siberia . . .	27	Eastern isles	14

nearly all of them being in the list of the 34 species which belt the world in the north temperate zone. For Amurland, Maximowicz gives 21 species, six of which are not European. Turning to the south-west, we find for Asia Minor only 25 species, all of them European. The small Syrian and Palestinian fern-floras are also European entirely; in fact we do not get a single addition in this direction to the European list till we reach the Himalayas. The number of Himalayan species we may state safely at 320. In separating these out into subtropical and typically temperate, I have had to rely almost entirely upon the notes of Dr. Hooker and Dr. Thomson, who have observed and recorded carefully the altitudes of all the species they gathered. Taking the temperate region as beginning at 5000 feet above the sea-level in the Eastern Himalayas, and at the base of the hill-country in the north-west, we have definite knowledge that 184 species grow above this line. These are the species which are marked with the figure 3 in the third column of our table. There can be no doubt that this figure is too low, as we have no definite information as to the heights at which Wallich, Griffith, and others gathered their specimens, and I have not included any species as temperate on mere presumption alone; so that there is every probability that further exploration will raise it considerably above 200. Passing from north-west to south-east along the range, we find the European species gradually disappear; whilst from the Malayan isles, the second in importance and productiveness of the great tropical fern-centres, along the humid jungly shore of the Malay peninsula, a crowd of subtropical species extend to the slopes of the southern flank of the eastern extension of the Himalayan range, and find a congenial home in the close humid valleys of Khasia, Sikkim, and Assam, where the hill-spurs shut out the wind, and the rays of an almost vertical sun fall upon dense masses of subtropical forest-vegetation. According to our present knowledge, this subtropical region of the Himalayas yields 136 species not known in the temperate region above it; and many of the species that extend into the latter have their head quarters here. It is of course evident that it is through the combination of conditions of station and climate brought about by the Himalayan range filling the geographical position which it occupies, and no doubt partly also by reason of the proximity of the range to one of the great head

quarters of the order, with a suitable highway of communication between the two, that temperate Asia is so much richer in ferns than any other of our five temperate districts. To see this, we need only contrast the 136 subtropical species added here with the 2 species added to the European list in North Africa. Passing from the Himalayas eastward we have a few peculiar species in temperate East China, but the number is very small. The Japanese fern-flora is a remarkable one, on account of, latitude considered, its richness and southern character. Of the species in the Synopsis, 118 are known to us clearly as inhabiting the Japanese group of islands, exclusive of the Bonin and Loo-Choo clusters. In latitude Japan is about upon a par with the Spanish peninsula, and considerably smaller in area; but the Japanese ferns are to the Spanish as three to one—118 species against 39. We see here well shown, what was indicated before by the British list, how that with ferns an insular position may compensate to a very large extent for the effect of a higher latitude. Of the Japanese species, 20 are peculiar, 14 restricted to Japan and other parts of temperate Asia; we have only 17 out of the 34 European species which belt the globe; and the others, at any rate we may safely say 60 species, are characteristically subtropical, and nearly all of them Malayan. If we classify according to their geography the peculiar species of temperate Asia, the following will be the result:—

Restricted to the Himalayas	. . . . .	66
„	the Japanese isles	21
„	Korea and Siberia	4
„	East China	6
Common to Japan and the Himalayas	. . . . .	1
„	East China and the Himalayas	2
„	Japan and Siberia or Korea	5
„	Japan and East China	9
	Total	114 species.

The most remarkable circumstance thus elicited is the absence of that affinity which we might *à priori* expect between the essentially temperate species of the Japanese and Himalayan lists. We find, in point of fact, that such an affinity can scarcely be said to have any existence, and that the species which the two floras have in common are the subtropical ones common to Malaya also, and not the characteristically temperate forms. Comparing the list for temperate Asia, as a whole, with that of the two other north temperate districts, we find 34 species common to it and both the other two. In addition to this there are 18 species which are European or North African and Asiatic, but not American, and eight species which are Asiatic and American, but not European. The latter are:—

Onoclea sensibilis.
*Adiantum pedatum.
*Pellæa gracilis.
*Blechnum serrulatum.
*Asplenium thelypteroides.
Nephrodium fragrans.
Osmunda Claytoniana.
*—— cinnamomea.

Of these the five marked with an asterisk extend to the Himalayas, and the other three are confined to Manchuria and Siberia.

4. *Temperate North America.*—Next to Europe and North Africa, this has the smallest fern-flora of the temperate districts—114 species, 5 per cent. of the whole. They may be classified as follows :—

Essentially temperate species peculiar to it			. . . . .	37
,,	,,	,,	common to Asia and Europe . .	34
,,	,,	,,	common to Europe	2
,,	,,	,,	common to Asia	8
				81

and the remaining 33 species are nearly all subtropical species common to this district and the tropical zone of the same continent. The most prominent point to be noted is the smallness of this last element. The northern half of Mexico is extratropical; and if the species which grow there were included, the number of subtropical species would be considerably increased. Comparing this district with Europe, which on the whole it resembles most, the greater range and abundance of several of the peculiar species is noteworthy. We have instances of this furnished by *Woodwardia areolata* and *virginica*, *Polypodium hexagonopterum*, *Dicksonia punctiloba*, *Cystopteris bulbifera*, *Scolopendrium rhizophyllum*, *Nephrodium marginale*, *noveboracense*, and *Goldieanum*. All these have their head quarters in the Northern United States, which yield altogether 51 species. Throughout British North America we have only 46 species, 7 of which are absent from the Northern States. In the Southern States east of the Mississippi there are 56 species, 19 of which are not known in the Northern States; the remaining 37 are peculiar to California and New Mexico. About one-fifth of the ferns of the district belong to *Pellæa* and *Cheilanthes*, a group proportionally preponderant also at the Cape.

North Temperate Zone.—Taking the north temperate zone as a whole, we find it to yield 514 species, 34 of which are common to the three districts, 18 to the second and third, 8 to the third and fourth, and 2 to the second and fourth. Of these, 177 species, or one in three, are peculiar to it.

5. *Temperate South Africa.*—In temperate South Africa we have, within an area of under a million square miles, 153 species, or 7 per cent. of the order. Of these, 23 are peculiar to Cape Colony, 4 to the island of Tristan d'Acunha, 11 belt the world in the south temperate zone, 7 others are American, and 19 Australian; the remaining 89 are species common to this district and the tropics, 20 of them being confined exclusively to tropical Africa. When we consider the strongly marked peculiarity of the phanerogamic flora of this district, the lack of individuality in its fern-flora is remarkable. Even out of these 23 peculiar species 4 or 5 are doubtfully distinct. The three most distinct of them are pseudofilices—*Schizæa pectinata*, *Anemia Dregeana*, and *Ophioglossum Bergianum*. Ten species out of the 23 belong to *Pellæa*, *Cheilanthes*, and *Notochlæna*, of all groups perhaps the least moisture-needing in its stations. The species which the districts of the south temperate zone have in common, it may be noted here once for all, are several of them not

characteristically temperate, but plants which have their head quarters within the tropics and occur less abundantly outside them. Of well-marked truly temperate species common to the Cape and Australia we may note *Todea barbara*, *Asplenium bulbiferum*, and *flaccidum*, and, amongst those common to the Cape and temperate South America, *Polypodium incanum* and *Lomaria Magellanica*. To meet with *Aspidium falcatum* and *Asplenium varians* again we must go from the Cape to the Himalayas, and for *Asplenium ebeneum* and *Pellæa andromedæfolia* to North America. Of well-marked species confined to Africa, which have their head quarters here but pass slightly within the tropic, *Pteris flabellata*, *Mohria caffrorum*, *Cyathea Dregei*, and *Notochlæna inæqualis* are examples. Considering the smallness of the tropical-African list, the addition to that of this district of 89 tropical species is large; but several of them inhabit Mauritius and Madagascar, and do not pass further south than Natal.

We have included Tristan d'Acunha in this district. This little island is not more than twenty miles in circumference, and is situated in the midst of the Atlantic, nearly in the latitude of Cape Town and Monte Video, where the distance between the two continents is one-fifth of the whole circumference of the globe. It is about ten degrees nearer to Africa than America, and is remarkable for having the flora in which, as compared with all others that are known, the ferns are most nearly upon an equality in number of species with the flowering plants. The following is its fern-list, 23 species, Lycopodiaceæ not included, the number of flowering plants enumerated by Captain Carmichael (Linn. Trans. vol. xii. p. 483) being 29:—

*Hymenophyllum æruginosum.
Adiantum æthiopicum.
Pteris incisa.
Blechnum australe.
Lomaria alpina.
—— Boryana.
Asplenium obtusatum.
—— erectum.
—— monanthemum.
*—— medium.
Trichomanes tenerum.
Nephrodium tomentosum.
Aspidium coriaceum.
*Polypodium aquilinum.
—— punctatum.
—— australe.
Gymnogramme cheilanthoides.
*Vittaria stricta.
Acrostichum conforme.
—— hybridum.
—— spathulatum.
——succisæfolium.
Ophioglossum bulbosum.

It is curious to analyze this list and compare it with that of St. Helena. Here we have four peculiar species (those marked with an asterisk), three only found elsewhere in the Mauritius, nine which are both Cape and American, six which are American but not Cape, and one which is nominally Cape but not American, but very doubtfully distinct from a common American plant. There are only 18 species altogether which are common to temperate South America and the Cape; and here we have half of them on this little isolated halfway island. Whilst St. Helena, which is much nearer a continent, has more than half its ferns peculiar, here we have only a sixth of them; and although it is nearer Africa than America, the affinity is considerably closer with the latter. It is included by Dr. Hooker in the so-called Antarctic flora.

6. *Temperate Australia and New Zealand.*—Of the south temperate districts this is the largest and most fertile, yielding a much larger number of species and of peculiar ones than any other temperate district except the third. The total number of its ferns is 212; and of these one in three is peculiar to it. Taking Australia and New Zealand separately, we obtain the following results:—

New Zealand.

Species quite peculiar to the island	34
Not peculiar, but not Australian	12
Common to New Zealand and Australia	67
Total	113

Australia.

Species quite peculiar	25
Not peculiar, but not New Zealand	68
Common to New Zealand and Australia	67
Total	160

Of the 74 species peculiar to the district, 34 are confined to New Zealand, 25 to Australia, 11 only are common to both, and 4 inhabit the small adjacent islands. Eleven species are common to this district and the other two south temperate ones, 12 others to this and South temperate America, and 19 others to this and the Cape. The 12 New-Zealand species which are not peculiar, but do not occur in Australia, are nearly all plants of the Polynesian islands; and the 68 Australian species which are not peculiar, but do not occur in New Zealand, are many of them subtropical Malayan species which do not reach further south than Queensland. To complete the Australian list, it must be borne in mind that a few (not more than three or four) species require to be added, which are restricted to the tropical part of it.

7. *South Temperate America.*—We have included the whole of Brazil with tropical America, and know so little of the ferns of Uruguay and La Plata that our list for this district applies principally to Chili and Patagonia. It includes 118 species, of which 32 are peculiar, 11 common to this and the other two south temperate districts, 12 others to this and the last, 7 to this and the Cape. The other 58 are tropical American species which pass beyond the tropic; and, as before indicated, we cannot regard all those that are common to this and the other two south temperate zones as characteristically temperate.

South Temperate Zone.—Taking the south temperate zone as a whole, we find it to yield 423 species, 131 of which are peculiar to it. It is only one-fifth the area of the north temperate zone; but both the total number of species and the number of peculiar ones are to those of the latter as 4 to 5.

8. *Tropical Africa.*—This district offers a great contrast to the other two tropical ones in its fern-geography, and is even considerably below temperate Asia in the number of species it yields. Beginning with the Cape Verde islands, we find in the group a total

absence of individuality. There are only 13 species in all, not one of which is peculiar. *Asplenium Hemionitis* and *Notochlæna lanuginosa* are not tropical African, but they are both Canarian and Mediterranean; and *Nephrodium odoratum* is not known nearer than Mauritius. For the west side of the continent, from Senegambia southward, through Guinea to Angola, the botany of which the recent explorations of Barter, Mann, and Welwitsch have done so much to make known to us, we can now enumerate 197 ferns, 47 of which are peculiar. Of these, 116 are common to both sides of the continent, 6 being restricted to Angola, and most of the other 41 to Guinea and Senegambia. A small number (13) of West-African species are very interesting geographically, as being essentially tropical, and common to tropical America and Africa, but absent from Asia. This is the case with

Hymenophyllum ciliatum.
Pteris Chilensis.
Trichomanes crispum.
Asplenium serra.
—— dimidiatum.
—— cicutarium.
Nephrodium hirtum.
Nephrodium subquinquefidum.
Polypodium cultratum.
—— rigescens.
—— glaucophyllum.
Acrostichum hybridum.
—— villosum.

St. Helena comes next of known floras to Tristan d'Acunha in the proportion which Ferns bear to Phanerogamia, which is nearly as two to three; and it is very remarkable from the fact that half of them are peculiar to it. The St. Helenan list is as follows:—

*Dicksonia arborescens.
*Hymenophyllum capillaceum.
Cheilanthes multifida.
Pteris flabellata.
*—— paleacea.
*Asplenium compressum.
—— erectum.
*—— platybasis.
—— furcatum.
—— lanceolatum.
*—— nigro-paleaceum.
Nephrodium patens.
*—— Napoleonis.
*Nephrodium cognatum.
*Polypodium molle.
—— marginellum.
—— punctatum.
—— lanceolatum.
Monogramme, sp.
—— graminoides.
*Gymnogramma Haughtoni.
*Acrostichum dimorphum.
*—— bifurcatum.
*—— subdiaphanum.
—— conforme.
Ophioglossum vulgatum.

The peculiar species are those marked with an asterisk. Analyzing the list, we find the result as follows:—

Species peculiar to the island	13
Common to Africa and America	7
African, not American	2
American, not African	2
Canarian, neither African nor American	1
Total	25

Ascension Island yields only seven species, as follows :—

Pteris incisa.	Polypodium trichomanoides.
—— flabellata.	*Gymnogramma Ascensionis.
Asplenium erectum.	Marattia fraxinea.
*Nephrodium Ascensionis.	—— ——, var. purpurascens.

Two of these are peculiar, two common to Africa and America, two African only, one American only; so that it is very curious to note that, if we sum up in a single phrase the leading characteristic of the Fern-floras of the Atlantic islands, it is in each case different.

Of Tristan d'Acunha, the characteristic is	American affinity.
St. Helena	Individuality.
Ascension Island	The want of any decided characteristic.
Canaries, Madeira, and Azores	Mediterranean affinity.

We must note, in passing, the want of individuality in the Angolan Fern-flora. A few of the Angolan ferns are Cape species which do not reach Guinea; but the rest, with the exception of six species, all occur elsewhere in this district. For the east side of the continent, principally through the explorations of Schimper in Abyssinia, and Kirk in Zambesi-land, we know now 133 species; but here there is even still less individuality than in Angola—not a single peculiar species in Zambesi-land, and in Abyssinia only one. *Asplenium pumilum* is an east continental species only known elsewhere in America, *Cheilanthes Kirkii* in Angola, *Cheilanthes arabica* and *Onychium melanolepis* in Arabia and Persia.

Taking next the East African islands, including Madagascar, Mauritius, Bourbon, and the Seychelles and Comoro groups, we find that they have a Fern-flora which presents several points of interest. The total number of species is a little over 200; and very likely, when Madagascar is better explored, it will be raised to 250. But dealing with it as we know it at present, we find that more than half the species are not known in the tropical parts of the continent, that more than a quarter of them are absolutely peculiar, and that it has a strong Indo-Malayan affinity, as the following analysis will show :—

Species known in Tropical Africa		90
,,	quite peculiar	56
,,	Tropical Asiatic	40
,,	Cape	12
,,	American	7
,,	Australian	3
,,	Tristan d'Acunha	3
,,	Temperate Asiatic	2
	Total	213

The American species are, besides some already mentioned for West Africa, *Hymenophyllum lineare*, *Nephrodium conterminum*, *Aspidium mohrioides*, *Polypodium parvulum*,

Acrostichum lineare, and *Ophioglossum palmatum*; the Australian, *Hymenophyllum gracile*, *Nephrodium hispidum*, and *Platycerium alcicorne*. In the above analysis the Seychelles are included; but very likely, when we know them better, it will be worth while to consider them separately. So far as we know their flora, most of the species are both Mascarene and Indo-Malayan; but there are three peculiar species, and two which are Malayan but not African. Summing up the district as a whole, we find that it has 346 species, the peculiar ones being distributed as follows:—

Mascarene isles	54
Guinea aud Senegambia	41
St. Helena	13
Common to East and West	8
Angola	6
Seychelles	3
Abyssinia	1
Common to East and Mauritius	1
Total	127

9. *Tropical Asia.*—We come now to the great centres of fern-distribution. Our list for tropical Asia and Polynesia as a whole includes 863 species, 39 per cent. of the whole order, out of which 477 species are peculiar to the district. Beginning in the west, we find a million square miles in tropical Arabia almost a blank so far as Ferns are concerned. Forskahl's list for Arabia Felix includes only nineteen species, and we do not know one that is peculiar. The Ferns of Peninsular India are very much concentrated in the range of hills that runs parallel with the western coast from Bombay to Cape Comorin, especially in the Neilgherries. Of the state of things in the drier tracts of the centre, we may form an idea from Mr. Edgeworth's florula of Banda, which only includes seven Ferns for a district which produces upwards of 600 flowering plants. There are probably very few additions yet to make to the Ferns of Southern India and Ceylon; and we have a full account of them in the recent works of Dr. Thwaites and Captain Beddome, the latter containing quarto plates of all the known species. We may reckon the number of species at 250, of which 200 are Ceylonese. The number of species which are neither Malayan nor Polynesian is 46, of which half are peculiar, the others nearly all Himalayan. Of well-marked peculiar species we have instances in *Cyathea Hookeri* and *sinuata*, *Asplenium zeylanicum*, *Nephrodium deparioides*, *Polypodium Gardneri* and *zeylanicum*; of species common to South India and the Himalayas, but not elsewhere known, in *Cyathea spinulosa*, *Sphæropteris barbata*, *Asplenium normale*, *Aspidium auriculatum*, *Nephrodium cuspidatum*, *Polypodium membranaceum* and *hemionitideum*. *Cheilanthes myriophylla* and *Pteris palmata* only grow elsewhere in tropical America, *Pellæa Boirini* in South Africa, and *Acrostichum spathulatum* in Natal, tropical America, and Tristan d'Acunha. Of the Ferns of Siam and the country to the east we know nothing. For the island of Hong Kong 75 species are enumerated in Bentham's 'Flora,' of which three are peculiar, and two interesting species—*Brainea insignis*, known elsewhere only

in Khasia, and *Alsophila podophylla* on the mainland further north. For Formosa the collections of Oldham, received lately, contain 81 species; and several others have been sent by Mr. Swinhoe, making the number about 100 in all. But the great concentration is in the narrow Malayan peninsula and Malayan and Philippine groups of islands. Here, in a space not more than a hundredth of the globe in area, we have more than a quarter of the known Ferns gathered together. For this tract we can now enumerate 630 species as they stand in the Synopsis; and still Borneo, Celebes, and Sumatra can only be regarded as very partially explored; but of these 630, 250 are absolutely peculiar, about one in nine of the known Ferns. Seventy other species are not known in Polynesia and peninsular India, of which upwards of fifty are Himalayan. Our list for Polynesia contains now 380 species, of which about 150 are absolutely peculiar, and 30 others not Malayan, the latter mostly occurring in New Zealand or Australia. Taking Polynesia as a whole, the most noteworthy point about it seems to be that the portion of its Fern-flora that is not peculiar is, with the exception of a faint Australian tinge, thoroughly Malayan, not American. We may conveniently subdivide the islands into three groups:—first, a western one, including New Guinea, New Caledonia, and the Solomon and Loyalty Isles; second, a central group, including the Society and Friendly isles, Samoa and Fiji; and, third, a north-eastern one, including the Sandwich Isles. About the first group we know very little; and that little has principally been gained through the recent travels in New Caledonia of M. Vieillard. His collections, happily for science, were worked up by Mettenius, in whose death, occurring as it has so soon after that of Sir W. Hooker, Fern-literature has sustained a loss that can scarcely be estimated too highly. We know already, in this western group, 55 of the species peculiar to Polynesia; and no doubt further investigation will add to the number largely, and add, in this group, to the Polynesian list many species now known in Malaya alone. The central group we know much more thoroughly, principally through the explorations of Powell in Samoa, of Seemann and others in Fiji, and of Brackenridge in nearly all the islands. For Samoa the list will reach nearly to 150 species, and for Fiji exceed 200. In this central group we know 47 of the peculiar Polynesian species, mostly special to the group; and here many of the Malayan types reach their eastern limit. The Sandwich Islands have a smaller list, many of the Malayan species that grow in the other two groups being absent here. The number of peculiar species is smaller than in the other two, being only 37; but several of them are very distinctly marked plants, as, for instance, the three species of *Cibotium*; whilst *Sadleria* is nearly, and *Diellia* (placed in the Synopsis under *Davallia*) quite confined to the group. The only American species which we can call to mind as known here and not further west are *Pellæa ternifolia* and *Asplenium fragile* and *Sandwichianum*. To this group in Polynesia *Aspidium aculeatum* and *Nephrodium Filix-mas* appear to be restricted; and we do not know *Cystopteris fragilis*, *Asplenium Adiantum-nigrum*, and *Trichomanes monanthemum* anywhere else in tropical Asia.

10. *Tropical America.*—But, taking it as whole, tropical America is the most productive district, in peculiar species especially, of which, indeed, it has nearly as many as all the other districts put together. It is here, amongst the dripping rocks of the higher

levels of the Andes, the forests of their slopes and ravines, and the dense humid flats that border the innumerable branches of the Amazon, where the sun's rays and the wind never penetrate the recesses of the primeval jungles, and climbers and parasites contest with the leaves of bright-flowering trees for the possession of the branches, that we obtain the great concentration of species. Our list for tropical America contains 946 species, 42 per cent. of all that are known; and of these more than three out of four are quite peculiar to it. And as by gradual degrees, as traveller after traveller brings or sends to Europe the result of his explorations, our knowledge of the distribution of the species is increased, two points are more and more brought out into prominence—that all this vast area constitutes, in any broad sense of the term, but one single and indivisible Fern-region, and how prominently individualized the characteristics of that region are. It has one Fern out of every three that are known in the world quite peculiar to itself; and yet a very considerable proportion of these reach from Mexico and the West-Indies on the north, to Peru and the south of Brazil; and how completely the West-Indian Islands form part of the same region may be judged from the fact that whilst they yield upwards of 400 species, and have been much better explored than the adjacent parts of the continent, only one species in seven has not been gathered on the mainland; and for the Galapagos group we know clearly only one species which does not occur upon the mainland.

Torrid Zone.—Taking the Torrid zone as a whole, we find that it yields 1901 species, 85 per cent. of the whole Order, and that of these 1437 species 65 per cent. of the Order are peculiar to it, upwards of 1000 species being confined to tropical America and Malaya.

Comprehensive Areas.—The following are all the species that grow in more than half the districts.

Six districts, 15:—*Hymenophyllum polyanthos*, *Trichomanes radicans* and *rigidum*, *Lomaria attenuata*, *Asplenium monanthemum*, *bulbiferum*, and *umbrosum*, *Nephrodium Thelypteris* and *spinulosum*, *Nephrolepis acuta*, *Polypodium vulgare*, *Gymnogramma leptophylla*, *Vittaria lineata*, *Acrostichum conforme*, *Botrychium Lunaria*.

Seven districts, 12:—*Hymenophyllum Tunbridgense*, *Adiantum Capillus-veneris*, *Pellæa geraniæfolia*, *Pteris longifolia*, *incisa*, *and cretica*, *Asplenium Trichomanes* and *furcatum*, *Nephrodium unitum* and *molle*, *Polypodium punctatum*, *Osmunda regalis*.

Eight districts, 2:—*Adiantum æthiopicum*, *Nephrodium filix-mas*.

Nine districts, 3:—*Pteris aquilina*, *Asplenium filix-fœmina*, *Ophioglossum vulgatum*.

Ten districts, 2:—*Cystopteris fragilis*, *Aspidium aculeatum*. Total, 34.

In the tropics 64 species belt the globe, in the north temperate zone 34, in the south temperate zone 11. Ninety-one species grow both north and south of the tropics, of which the following 26 have a range of 70 degrees of latitude:—

Hymenophyllum polyanthos.	Adiantum Capillus-veneris.
—— Tunbridgense.	—— æthiopicum.
Trichomanes filicula.	Pteris aquilina.
—— pyxidiferum.	Asplenium Trichomanes.
—— rigidum.	—— monanthemum.

Asplenium Ruta-muraria.
—— Adiantum-nigrum.
—— solidum.
Asplenium filix-fœmina.
Aspidium aculeatum.
Nephrodium Thelypteris.
—— filix-mas.
—— spinulosum.
Polypodium punctatum.
—— vulgare.
Gymnogramma leptophylla.
Osmunda regalis.
Ophioglossum lusitanicum.
—— vulgatum.
Botrychium Lunaria.
—— ternatum.

Dissevered Areas.—Besides those which have been noticed under the different districts, the following are instances of curiously dissevered areas:—

Aspidium falcatum.	Japan, Himalayas, Neilgherries, Sandwich Islands, Natal, Kaffraria.
Deparia prolifera.	Sandwich Isles, Queensland.
Hymenophyllum obtusum.	Sandwich Isles, Cape Colony.
Woodwardia radicans.	United States, California, Mexico, Himalayas, Java, shores of the Mediterranean, Canaries.
Gymnogramma Pozoi.	Spain, Australia, Chili.
Notochlæna lanuginosa.	Shores of the Mediterranean, Cape Verde Islands, Madeira, Australia temperate and tropical.
Nephrodium albo-punctatum	Mauritius, Guinea coast, Amboyna, Fiji.
Davallia concinna.	Cape, Angola, Abyssinia, tropical America, Guinea.
Gymnogramma calomelanos.	Guinea coast, Samoa, tropical America.
Asplenium anisophyllum.	Cape, West Africa, tropical America.
Acrostichum Aubertii.	Natal, Mauritius, tropical America.

The following is a summary of the distribution of the Order divided out into tribes:—

	Total species.	Frigid zone.	North Temperate zone.			South Temperate zone.			Torrid zone.		
		1	2	3	4	5	6	7	8	9	10
1. Gleicheniaceæ	25	0	0	2	0	2	8	3	4	11	6
2. Cyatheæ	143	0	0	8	1	3	11	4	12	50	74
3. Dicksonieæ	53	3	5	16	9	1	6	2	3	17	15
4. Hymenophylleæ	151	0	2	16	2	10	26	21	26	54	66
5. Davallieæ	86	2	5	26	3	4	4	1	12	57	12
6. Lindsayeæ	49	0	0	4	0	1	8	0	5	29	17
7. Pteridæ	312	3	13	52	28	33	42	27	54	81	152
8. Blechneæ	31	0	1	7	4	1	8	3	1	10	11
9. Asplenieæ	284	4	21	64	12	29	19	11	64	116	102
10. Scolopendrieæ	9	0	2	2	2	0	0	0	0	1	4
11. Aspidieæ	292	6	13	81	16	18	20	10	54	129	99
12. Polypodieæ	384	4	5	72	14	21	26	17	42	170	165
13. Grammitideæ	168	0	5	29	7	13	9	13	22	61	80
14. Acrosticheæ	135	0	1	13	1	7	6	1	31	45	80
15. Osmundaceæ	9	0	1	4	3	2	4	0	1	4	2
16. Schizæaceæ	60	0	0	5	4	5	7	3	6	14	37
17. Marattiaceæ	21	0	0	2	0	1	2	0	2	5	15
18. Ophioglossaceæ	17	3	7	9	8	3	6	3	7	9	7
Total	.....	25	81	412	114	154	212	119	346	863	944
Percentage of the order	.....	1	4	18	5	7	9	5	15	39	42
Peculiar species	.....	0	12	114	37	22	74	32	127	477	757

The general Plan of Distribution.—To illustrate the most striking point about the general distribution of the Order, I will borrow a quotation from Mr. Darwin*:—"Some few families, many subfamilies, very many genera, and a still greater number of sections of genera, are confined to a single region; and it has been observed by several naturalists that the most natural genera, or those genera in which the species are most closely allied to one another, are generally local, or confined to one area." The remarkable point about the distribution of Ferns is, that, as may be seen from this last Table, there is so little trace amongst them of this concentration of allied forms in the same district. Most of the tribes are distributed through the districts in very much the same proportion as the whole Order; and in the genera there is no striking exception to the same plan. Although three-quarters of the species are confined to single districts, the only instances in which any district has more than half the species of a tribe are the following:—

Tropical America.—Cyatheæ, Acrosticheæ, Schizæaceæ, Marattiaceæ.

Tropical Asia.—Davallieæ, Lindsayeæ, Ophioglossaceæ.

Temperate Asia.—Ophioglossaceæ.

That is to say, in eight instances out of 180 possible cases; and the highest percentage which any tribe containing more than 100 species attains in any district is 68. Consequently the leading characteristic of each district is expressed by giving the percentage of the whole number of species which it yields,—not, as is so often the case in flowering plants, by saying that such and such orders, groups, or genera, characterize it specially. The theoretic bearings of this, which it is beyond the scope of my present paper to discuss, are well worthy of attention.

* Origin of Species, p. 353.

THE

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IX. *A Monograph of the Recent British* Ostracoda.

By George Stewardson Brady, *Esq.* *Communicated by* Dr. Sclater, *F.L.S. &c.*

(Plates XXIII.–XLI.).

Read May 3rd, 1866.

Since the publication, in 1850, of Dr. Baird's work on the British Entomostraca, much has been done towards the elucidation of the anatomy and physiology, as well as the distribution and zoological classification, of these animals, and probably no group has received a larger share of attention than the Ostracoda. The interest attaching to this group is much enhanced by the fact that they alone, of all the higher Microzoa, are found in the fossil state in sufficient numbers to afford grounds for any exact comparison between the fauna of the present and those of bygone ages; and it is, of course, only by the diligent collecting and accurate description, both by pen and pencil, of the forms now living in our lakes and seas, as well as of fossil species, that much progress in this direction can be made.

The classification hitherto in vogue has rested almost entirely upon external shell-characters and mode of hingement; and, seeing that by far the greater number of species have been described from fossil specimens, no other method was, of course, practicable. But though the careful study of the shells, which has necessarily accompanied such a plan of classification has been very advantageous, and has, indeed, resulted to a considerable extent in a really natural grouping and arrangement of genera and species, it is obviously an unsatisfactory and unsound basis of classification; and much has been recently done by various continental authors to increase our knowledge of the minute structure of the animals themselves. Among the naturalists who have been foremost in this work may be mentioned Professor Lilljeborg, Fischer, Zenker, and G. O. Sars. The admirable memoir of the last-named author, 'Oversigt af Norges marine Ostracoder,' published in 1865, contains descriptions of all known Norwegian marine species classified according to the anatomical characters of the animals, the structure of most of which is there for the first time minutely described. This work forms, indeed, an epoch in the study of the Ostracoda; and its author deserves the warmest acknowledgments of all carcinologists for the light which he has thrown, at the expense of much time and labour, on the minute structure and affinities of the creatures of which he treats. To British naturalists the work is, indeed, especially valuable, on account of the close relationship existing between the faunas of the two countries; and I have, in this monograph, adopted, with but little modification, the arrangement and classification propounded by the author of the 'Oversigt.' The greatest difficulty which I have myself experienced arises from the fact that by far the larger number of my deep-sea specimens have been dried in the first instance with the mud or sand in which they were

taken, and afterwards picked out one by one. By this method the animal structure contained in the shell is almost always entirely destroyed, or at any rate is so far decomposed as to be quite unfitted for any critical examination. On this account I have often been unable to give anatomical descriptions of deep-water species. There can be no doubt that by proper treatment of the dredged material shortly after its removal from the sea-bed, the contained Microzoa might to a large extent be obtained in a serviceable and perfect condition; while, in the case of material taken in the hand-net or towing-net, it need never be a difficult matter to separate the Ostracoda with the help of a simple pocket-lens.

As to the manipulation of the animals and their preparation for the microscope, it is seldom that much difficulty will be experienced in separating the valves by means of fine needles, and then detaching the contained animal; the various organs are rendered much more distinct by immersion for a short time in a solution of potash, by which the oleaginous and granular constituents are to a great extent removed, the chitinous structures remaining unaffected. If it be desired to mount permanently the dissection thus made, the best medium for the purpose is a compound of glycerine and gelatine with a slight addition of arsenic, the formula for which is given below*. This preparation has the advantage of becoming fluid at a low temperature, of retaining its moisture sufficiently without any cementing of the glass cover, and of being colourless and very easy of application.

The geographical and bathymetrical distribution of the Ostracoda is a matter of the greatest interest as illustrating the probable conditions under which the various fossiliferous strata have been deposited. The data at present at our command are somewhat scanty, and negative evidence must be taken for no more than it is worth; but some portions of the British coasts, as, for example, those of Northumberland and Durham, and the Frith of Clyde, have been pretty diligently dredged and investigated with a view to the study of these organisms. I have therefore brought together, in a tabular form at the end of the monograph, the principal districts in which the marine species have been examined, and have endeavoured roughly to indicate their frequency and range of depth by means of signs, as explained in the Table. The two final columns indicate the occurrence or non-occurrence of the species in the Scandinavian seas, and in the Tertiary or Posttertiary deposits of Great Britain and Norway. For the information given respecting the recent Scandinavian species I am indebted entirely to Herr G. O. Sars and Professor Lilljeborg; the column relative to fossil species owes its completeness chiefly to the labours of Messrs. Crosskey and Robertson.

I must here express my great obligations to many kind friends for the communication of dredgings and specimens from various parts of the country,—to Mr. J. Gwyn Jeffreys and Mr. C. Spence Bate, Mr. E. C. Davison, of Sunderland, Mr. S. S. Stoddart, of Bristol, and

* Take any quantity of Nelson's gelatine, and let it soak for two or three hours in cold water which has previously been saturated with arsenious acid; pour off the superfluous water, and heat the soaked gelatine until melted. To each fluid-ounce of the gelatine add one drachm of alcohol, and mix well; then add a fluid-drachm of the white of an egg; mix well while the gelatine is fluid but cool. Now boil until the albumen coagulates and the gelatine is quite clear. Filter through fine flannel and to each fluid-ounce of the clarified gelatine add six fluid-drachms of Price's pure glycerine, and mix well.—*Carpenter's Microscope and its Revelations*, 3rd edition, p. 775.

Mr. D. O. Drewett, of Jarrow. My thanks are also especially due to Dr. Baird, of the British Museum, Professor T. Rupert Jones, the Rev. Alfred Merle Norman, Dr. Alcock, of Manchester, and Mr. David Robertson, of Glasgow, for much valuable advice and assistance, and for the kind and liberal manner in which they have placed their collections at my disposal; lastly I owe similar thanks to M. Bosquet, of Maestricht, Dr. Oscar Speyer, of Hesse Cassel, and Herr G. O. Sars, of Christiania, for the good service which they have done me by the communication of their admirable memoirs and series of illustrative specimens. I am fully conscious that whatever value this monograph may possess is owing in great measure to the generosity of these naturalists, and their kind interest in the progress of my work.

The recent Ostracoda are divided by Sars into four great groups or sections, namely :— (1) Podocopa, including the two families Cypridæ and Cytheridæ; (2) Myodocopa, including the families Cypridinidæ and Conchœciadæ; (3) Cladocopa, containing one family, Polycopidæ; and (4) Platycopa, containing also one family, Cytherellidæ.

The characters of these four sections may (after Sars) be stated as follows :—

1. Podocopa.—This is by far the most extensive of the four sections, including all the freshwater, and a vast majority of the marine Ostracoda, and embracing all the forms classed by the earlier writers under the two great genera *Cypris* and *Cythere*. The lower antennæ are here simple, pediform, geniculate, armed at the apex with sharp claws, and are used for swimming (as in *Cypris*), for walking (as in *Cythere*), or as prehensile organs. The first pair of appendages following the mouth is always a distinct maxilla, bearing a large halfmoon-shaped branchial plate, which is bordered with numerous ciliated setæ. The next pair of appendages forms in the Cypridæ a jaw of somewhat similar shape, but in the Cytheridæ becomes pediform, owing to the atrophy of the jaw proper and the greater development of the palp. Of the two following pairs of limbs, the last is found, in the Cypridæ, to have lost its use as a locomotive organ, and is doubled up between the valves, whilst in the Cytheridæ it is used, like the foregoing pair, as a walking limb. The postabdomen is, in the Cytheridæ, rudimentary, but in the Cypridæ is mostly well developed, consisting of two elongated laminar processes, lying close together, and each armed at the extremity with two long claws. The eyes are simple, often so close together as to appear single. The heart is always wanting; the digestive cavity has two dilatations, of which the foremost is (in the Cypridæ) provided with two lateral blind sacs. In this last family the organs of generation are produced between the two laminæ of the shell. These animals live for the most part an idle life, crawling leisurely on the mud, on plants, or swimming through the water. Their motions are effected by the two pairs of antennæ, which move synchronously, the upper pair moving up and down, the lower backwards and forwards, thus propelling the whole animal in a straight line.

2. Myodocopa.—This group comprises the forms of which the genus *Cypridina* is the type, the characters indicating a higher organization and presenting well-marked differences, which show an approach to the higher order Branchiopoda. As a rule the lower antennæ are here the only true locomotive organs, whilst the upper antennæ (as in the Branchiopoda) wholly lose their importance in this respect, and become the seats

of a special sense (smell or hearing), being clothed with toothed club-shaped appendages, which either proceed directly from the antennæ (*Conchœcia*), or from its bristle-shaped appendages (*Cypridina*). The lower antennæ consist of a particularly large and muscular basal joint and two branches, one of which may be rudimentary, whilst the other is cylindrical, flexible, and composed of numerous short joints, each of which bears generally on one side a long ciliated swimming-seta. The way in which these antennæ move is also quite peculiar. Whilst those of the previous group move upwards and downwards, these move from side to side. To allow of this movement the valves are peculiarly formed, so that when quite closed there is always an opening (mostly heart-shaped) through which the movements of the antennæ take place. In conformity with the development of these antennæ as locomotive organs, we find that the other limbs more and more lose their importance as such, and become subservient to the mouth as jaws. In *Conchœcia* the two hinder pairs are somewhat pediform; but their use as feet must be but small, as they can scarcely reach out of the valves. In *Cypridina* and the allied forms, the three pairs of limbs following the mouth are completely jaw-shaped, and the fourth or last pair, as in the Cypridæ, is bent up within the valves. The structure of this limb is so peculiar that one can scarcely class it as a foot or a jaw. The first pair of jaws possesses no branchial plate, which is constantly present in the foregoing group, but this appendage is transferred to the second pair (*Cypridina*), or the second and third pairs (*Conchœcia*). The postabdomen is developed into two broad symmetrical plates, armed with sharp claws, and is not unlike the same organ in the Cladocera. The eyes, when present, are fixed, as in the Branchiopoda, to large separate peduncles. In *Conchœcia* there are, at the roots of the upper antennæ, certain small bodies which take the place of eyes. In this group appears for the first time an independent heart, of structure similar to that of the Branchiopoda. The digestive canal has a single capacious stomach, which is invested throughout its whole length by a thick layer of liver-cells. Most of the forms belonging to this group are pelagic, and occur often in the open sea, near the surface of the water, where they move actively by means of the largely developed lower antennæ. Many of them are strongly phosphorescent in the dark, and must contribute essentially to the extraordinary brilliance of the tropical seas.

3. Cladocopa.—The type of this group is *Polycope*, a genus recently described by G. O. Sars, which occurs on some parts of the coasts of the British islands and Norway, and in the Mediterranean. The lower antennæ are very similar to those of the foregoing group, but are divided into two distinct and well-developed natatory branches. The movements of these organs are quite different. Whilst in the Cypridinidæ their motion is from side to side, it is here upwards and downwards as in the Cypridæ; and, in conformity with this, we find that the characteristic notch of the former family is absent. For these reasons it is necessary that the upper antennæ also should become natatory organs in order to bring the movement into equilibrium. The most curious point in these animals, however, is that behind the mouth we find two pairs of limbs, the last of which is used entirely for respiration, whilst the first pair or its palp is developed into a powerful two-branched swimming-organ. We have therefore, in this case, a group provided with no less than six swimming-organs; and on this peculiarity the

name of the genus (*Polycope*) is founded. On account of the minuteness of the animals, Sars has not been able to observe accurately their internal organization; but he asserts that the eyes are entirely wanting, and that the heart also appears to be absent. The digestive canal has a single capacious stomach, as in the foregoing section.

4. Platycopa.—This group is typified by the genus *Cytherella*, known, before Sars's researches, only from fossil specimens. The lower antennæ exhibit a structure so peculiar that this character alone would amply separate them from the other Ostracoda. They are very strongly developed, bearing considerable likeness to the swimming-feet of the Copepoda, but are still more muscular, and constitute very powerful swimming-organs. These consist of a broad flattened basal portion and two biarticulate broad branches, which bear numerous long bristles as in the Copepoda. The upper antennæ are of exceedingly robust build, and appear also to serve as locomotive organs. The mandibles are small and weak; but their palps are strongly developed, and that of the first jaw is armed internally with an elevated ridge which is beset with numerous toothed and flexuous setæ, bearing a remarkable likeness to the feet of the Cladocera (*Sida*, *Daphnia*). Behind the mouth follow, besides the first pair of jaws, only two pairs of limbs, of which neither has the remotest resemblance to feet; the last is, indeed, in the female, quite rudimentary, forming only a small setose lamina. Each of the two preceding pairs bears at the base a large halfmoon-shaped, numerously ciliated branchial plate. The abdomen is divided into several segments, most of which bear on the hinder part fasciculi of bristles. The postabdomen consists of two small plates, which are separate through their entire length, and bear at the extremity a number of slender spines. The shell is of very compact structure, so that it is found almost unaltered in very early geological formations. This group contains only one genus, *Cytherella*.

I have endeavoured to give, under each marine species, as accurate a statement of its distribution, both in the recent and fossil state, as the present state of our knowledge admits of; and with the view of indicating more clearly the relations of the species, I have classified them under several types, according to the geographical areas which they chiefly inhabit, the typical designation being always taken from the region in which the species appears at the present time to be most abundant.

We have at present scarcely sufficient knowledge of the distribution of the freshwater species to render a similar attempt with regard to them desirable.

The typical areas here adopted are as follows:—

1. Arctic type, including all species attaining their greatest development north of the isothermal line of 32° Fahr. *Glacial* might perhaps have been a more appropriate term for this group, but would have been liable to be confounded with the post-tertiary geological formations which go under the same name. My very limited knowledge of species from this tract is derived from specimens dredged by Dr. Sutherland, and from some parcels of mud obtained from whaling-ships by D. Robertson, Esq., of Glasgow.
2. Scandinavian type, comprehending the seas of Iceland, Norway, Sweden, Denmark, Shetland, and Northern Scotland. The Ostracoda of this district have been diligently collected by many naturalists, especially by Müller, Lilljeborg, G. O. Sars,

Norman, and Robertson; and our knowledge of them may be considered tolerably good.

3. British type, comprising species diffused pretty evenly over the seas of Great Britain and Ireland.

4. Atlantic type, referring to those which attain their greatest luxuriance on the south and south-western shores of England and Ireland.

5. Mediterranean type, including species which attain their maximum of development in the Mediterranean. These are very imperfectly known, chiefly from specimens described by Dr. Baird and myself, and from some further dredgings which have been placed in my hands by M. de Folin of Pauillac, and which I have already partially described in a French publication, 'Les Fonds de la Mer.'

It will be seen that the above is a very imperfect attempt at typical distribution; but such as it is, it seems to me to be better than none at all, and to add considerably to the interest attaching to the various species.

For the details of geological distribution, I am indebted much to the works of Prof. T. Rupert Jones, Bosquet, G. O. Sars, Reuss, Speyer, and Egger, but chiefly to the large collections of posttertiary species made, in anticipation of a monograph of the subject, by Messrs. Crosskey and Robertson, of Glasgow.

The following classified Table of the Ostracoda is compiled from various authors, and exhibits the present state of our knowledge of the subject. Those marked with an asterisk are known only in the fossil state; whether a right situation is here assigned them must be doubtful:—

Class CRUSTACEA.

Subclass ENTOMOSTRACA.

Order GNATHOSTOMATA.

Legion Lophyropoda.

Tribe Ostracoda.

Section Podocopa.

Family 1. Cypridæ.

Genus Cypris.
Chlamydotheca (?).
Cypridopsis.
Paracypris.
Aglaia†.
Notodromas.
Candona.
Pontocypris.
Argillœcia.
Bairdia.
Macrocypris.

Family 2. Cytheridæ.

Genus Cythere.
Limnocythere.
Cytheridea.
Eucythere.
Ilyobates.
Loxoconcha.
Xestoleberis.
Cytherura.
Cytheropteron.
Bythocythere.
Pseudocythere.
Cytherideis.
Sclerochilus.
Paradoxostoma.

Section Myodocopa.

Family 3. Cypridinidæ.

Genus Cypridina.
Asterope (?).
Bradycinetus.
Eurypylus †.
Philomedes.
Cylindroleberis.
Cypridella*.
Cyprella*.
Entomis*.

Family 4. Entomoconchidæ.

Genus Entomoconchus*.
Heterodesmus.

Family 5. Conchœciadæ.

Genus Conchœcia.
Halocypris.

Section Cladocopa.

Family 6. Polycopidæ.

Genus Polycope.

Section Platycopa.

Family 7. Cytherellidæ.

Genus Cytherella.

† Described by the present author in 'Les Fonds de la Mer.'

The following synopsis of the sections and families here described is given by Sars :—

OSTRACODA. Lower antennæ two-branched,	simple, subpediform, geniculate, clawed at the apex, not very unlike the upper antennæ. Both pairs of antennæ either bearing long setæ and adapted for swimming, or shortly setose and not used for swimming. Mandibles distinct, mostly strongly toothed at the lower extremity; palp of moderate size, and bearing a more or less developed branchial appendage. First pair of maxillæ bearing a large branchial plate. Feet	two pairs, the last bent up within the valves. Postabdomen forming two elongated narrow rami, which are usually clawed at the apex.	Cypridæ.	PODOCOPA.
		three pairs, all ambulatory, much alike in structure, and directed forwards. Postabdomen rudimentary, forming two very small lobes. Antennæ very little adapted for swimming.	Cytheridæ.	
	one branch rudimentary, immobile; the other elongated, cylindrical, flexible, many-jointed, armed with long natatory setæ, arranged in a single series; basal portion very large and stout, filled with muscular bands. Upper antennæ scarcely natatory. Mandibular palp very large, geniculate, subpediform, destitute of a branchial appendage. First pair of jaws without a branchial plate. Postabdomen divided into two broad plates, which are unguiferous behind. Feet	one pair only, of singular shape, forming an elongated, curved, flexible, annulated, vermiform appendage, which is spiniferous towards the apex. Upper antennæ large, distinctly jointed, geniculate at the base. Mandibles proper obsolete. Second pair of jaws bearing a large branchial plate. Eyes compound, pedunculated, widely separated; between the two in front a large simple eye and a short frontal tentacle.	Cypridinidæ.	MYODOCOPA.
		two pairs, the posterior very small and rudimentary; the anterior provided, like the second pair of jaws, with a small, lobed branchial plate. Upper antennæ of the female small and weak, immobile and indistinctly jointed. Mandibles distinct. No eyes. Frontal tentacle very large, and mostly dilated at the apex.	Conchœciadæ.	
	both branches well developed, moveable, and natatory. Upper antennæ also natatory, not geniculate, ending in a lash of long setæ. Mandibles distinct, palp short and scarcely pediform, provided with a small branchial appendage. Two pairs only of thoracic appendages: the anterior large, bifid, natatory: the posterior membranaceous and branchial. Eyes wanting. Postabdomen divided into two short laminæ, spinous behind.		Polycopidæ.	CLADOCOPA.
	flattened, similar to the feet of the Copepoda, basal portion biarticulate and geniculate; branches flattened, composed of few joints, and bearing numerous setæ on both margins. Upper antennæ very large and strong, many-jointed, geniculate at the base, shortly spiniferous. Mandibles small and weak, palp large. Three pairs only of thoracic appendages, all maxilliform. Palp of the mandible and first jaw bearing internally a comb of large setæ. First and second pairs of jaws provided with a large branchial plate; third pair rudimentary in the female, in the male well developed and prehensile. Postabdominal rami small and narrow, distinctly separated, and spiniferous at the apex.		Cytherellidæ.	PLATYCOPA

Section I. PODOCOPA.

Fam. 1. Cypridæ.

Valves mostly thin and smooth, more or less sinuated below. Upper antennæ mostly seven-jointed, and beset with numerous setæ, which form a dense brush of greater or less length; lower antennæ geniculate and bent backwards, four- or five-jointed, armed at the distal extremity with from three to five long, slightly curved claws, and bearing commonly on the posterior aspect of the antepenultimate joint a bundle of setæ. Mandibles powerful, and divided at the extremity into several teeth, bearing a large four-jointed palp, the first joint of which is provided with a branchial appendage. Two pairs of jaws: the first large, and divided into four digital segments, the anterior segment being larger than the rest, two-jointed and giving attachment to a large branchial plate:

second pair small, simple; in the female bearing a simple subconical palp, in the male often pediform. Two pairs of feet: the first stout and five-jointed, terminated by a long curved claw; the second pair more slender, and usually bent upwards within the valves. Postabdomen forming two long moveable rami, which are sometimes rudimentary and setiform, but oftener well developed and terminating in two strong curved claws. Eye single or altogether wanting; rarely two. Intestinal canal forming two pouches; ovaries and testes lying immediately beneath the shell. Copulative organs of the male situated immediately in front of the postabdominal rami, and provided with testes or mucus-glands of complex structure.

The animals belonging to this family have been considered, until very recently, to be inhabitants exclusively of fresh water. G. O. Sars, however, has shown that several forms hitherto classed among the Cytheridæ properly belong to the Cypridæ; these species now constitute the genera *Pontocypris* and *Macrocypris*; in addition to which other entirely new forms have been described under the names *Paracypris*, *Aglaia*, and *Argillæcia*. Lastly, the genus *Bairdia*, M'Coy, is here shown to belong to the same family.

The annexed Table shows the chief distinctive characters of the different genera. *Aglaia* and *Argillæcia*, however, have not yet been found in the British seas:—

CYPRIDÆ.	Second pair of jaws	possessing a branchial appendage; palp subconical, indistinctly jointed, ending in 3 setæ. Second joint of lower antennæ	bearing a brush of setæ. Setæ of the upper antennæ very long. Postabdominal rami	well developed, terminating in two strong curved claws	*Cypris.*
				rudimentary, setiform	*Cypridopsis.*
			without a brush of setæ. Setæ of the upper antennæ very short. First and second pairs of feet	alike	*Paracypris.*
				dissimilar	*Aglaia.*
		destitute of a branchial appendage. Palp	subconical, indistinctly jointed. Setæ of the lower antennæ	long, reaching beyond the apex of the terminal claws. Two eyes	*Notodromas.*
				altogether wanting. One eye	*Candona.*
			distinctly jointed, subpediform,	3-jointed. Upper antennæ	elongated, 7-jointed, armed with long setæ	*Pontocypris.*
					short and robust; 5-jointed, in the female shortly setose; in the male provided with a few long setæ	*Argillæcia.*
				4-jointed. Upper antennæ shortly setose. Postabdominal rami	largely developed, terminating in several long setæ	*Bairdia.*
					rudimentary	*Macrocypris.*

Genus 1. Cypris, Müller.

Valves mostly subreniform or elongate-oval, horny in texture. Upper antennæ seven-jointed, and beset with numerous long plumose setæ, which are mostly distributed as follows,—four from the apices of the fourth, fifth, and sixth joints, and three from the apex of the terminal or seventh joint. Lower antennæ five-jointed, bearing a fascicle of five or six setæ of variable length, and on the inner side of the third joint a short bi-articulate seta; terminating in four long curved and serrated claws; a few short setæ also arise from the sides of the fourth joint, near the middle. Second pair of jaws smaller than the first, in the male prehensile, and in the female consisting of a short, simple seti-

ferous lobe, a subconical, simple, or obscurely articulate palp, which projects backward, and terminates in three long setæ, and a small branchial plate, bearing six radiating respiratory setæ. Postabdominal rami long and slender, bearing at the apex two long and unequal curved claws, and a short seta; a short seta springs also from the inner margin of the ramus at or below the middle. The males furnished (mostly, if not always) with two mucus-glands, consisting of a cylindrical axis, on which are set seven whorls of radiating filaments, the whole connected with an efferent tube or "vas deferens."

The males of this genus are, except in a few instances, entirely unknown. Dr. Zenker has, indeed, in his excellent memoir on the anatomy of the lower Crustacea, given figures and descriptions of the males of three species; but two of these belong to the section comprised in the subgenus *Cypria* of that author, which may ultimately be found to present generic characters distinct from *Cypris* proper. Fischer has also figured and described the males of some few species. I have myself sought diligently for the males of many of the commoner species of *Cypris*, but have only seen one example belonging to *C.* (*Cypria*) *compressa*, Baird. This is one of the species figured by Zenker. Meantime the peculiarities of the group *Cypria* seem scarcely sufficient to warrant its separation as a distinct genus. The "testis," or "mucus-gland," though hitherto seen only in a few species, is doubtless present under some form in the males of all. And seeing that it is, to all appearance, the secretory gland of the spermatic filaments, or "spermatozoids," there seems no valid reason for applying to it any other name than that of *testis*.

The members of this genus inhabit exclusively fresh or slightly brackish water, and are mostly natatory animals; but a few of them, which have unusually short setæ attached to the lower antennæ, seem to be destitute of swimming-power, and constitute, in fact, a link between *Cypris* and *Candona*. In external appearance, as well as in habit of life, these approach the latter genus more closely than the former. To this category belong *C. reptans*, *serrata*, and *gibba*.

Though the structural differences observed amongst the Cyprides are not of generic importance, they are sufficient to form grounds of separation into several distinct sections as follows:—

a. Setæ of lower antennæ plumose, subequal, reaching about as far as, or only slightly beyond, the apex of the terminal claws.

* Second foot terminating in a short hooked claw, and one or more moderately long setæ.

** Second foot without a claw, ending in three setæ.

b. Setæ of lower antennæ non-plumose, very short, not reaching nearly to the apex of the terminal claws.

c. Setæ of lower antennæ plumose, unequal; two or three exceedingly long, the rest short. Second foot ending in three unequal setæ, one of which is exceedingly long.

a. *Setæ of lower antennæ plumose, reaching about as far as, or only slightly beyond, the apex of the terminal claws.*

* *Second foot terminating in a short hooked claw, and one or more moderately long setæ*

1. Cypris fusca, Straus. (Plate XXIII. figs. 10–15.)

Cypris pilosa (?), Müller, Entomostraca, p. 59, tab. vi. figs. 5, 6.

—— *fusca*, Straus-Durckheim, Mémoires du Mus. d'Hist. Nat. vii. p. 59, tab. i. figs. 1–16 (*fide* Baird) ; Baird, Brit. Entom. p. 154, tab. xix. fig. 7.

—— *oblonga*, Brady, Ann. & Mag. Nat. Hist. (1864) vol. xiii. p. 59, pl. iii. figs. 1–4; and Trans. Tyneside Nat. Field Club, vol. vi. p. 104, pl. ii. figs. 1–4.

Candona hispida, Baird, Brit. Entom. p. 161, tab. xix. fig. 4.

Carapace * oblong, oval; extremities rounded, the posterior somewhat narrowed: dorsal margin gently arched; ventral slightly sinuated. Seen from above, the carapace is broadly ovate, pointed in front and rounded behind; the greatest diameter a little behind the middle. End view suborbicular, somewhat angular above. The surface is rather thickly covered with long, fine hairs, and almost always bears patches of a dull furfuraceous character, apparently a desquamating epidermis; it is also superficially marked, more especially in young specimens, with a wrinkled or reticulated pattern. The colour is of variable shades of brown, with irregular transparent patches. Lucid spots about seven in number, long and narrow, and arranged obliquely across the valve. The abdominal rami are long and very slender, the terminal claws long and slender, subequal; marginal setæ very near the apices of the rami.

Length $\frac{1}{18}$ in., height $\frac{1}{30}$ in. †

This is one of the commonest of British species, occurring abundantly in ponds and stagnant water. I do not, however, remember ever to have met with it in lakes or streams.

The form described by me under the name of *C. oblonga* appears to be nothing more than an unusually elongated variety of this species. Müller's figures and description of *C. pilosa*, not hitherto identified by authors with the present species, are so very characteristic, that I feel little doubt that his specific name should be adopted on the ground of priority. His figure is certainly somewhat too small in comparison with some other species; but much stress cannot be laid upon a difference of this kind. Yet, as the name *fusca* seems now to be generally accepted by authors, I have not thought it desirable to propose an alteration the correctness of which might be open to doubt.

2. Cypris incongruens, Ramdohr. (Plate XXIII. figs. 16–22.)

Cypris incongruens, Ramdohr, Ueber die Gattung Cypris ; der Naturforsch. Freunde zu Berlin Magazin, 2. Jahrg. 1808, p. 86, tab. iii. figs. 1–12, 15, 16, 18–20 (*fide* Lilljeborg) ; Lilljeborg, De Crust. ex ord. trib. p. 119, tab. ix. figs. 6, 7, tab. xi. figs. 1–4, tab. xii. fig. 6.

—— *aurantia*, Baird, Brit. Entom. p. 159, tab. xix. fig. 13.

* The first clause of the specific descriptions refers in all cases to the *lateral* view of the carapace.

† The dimensions, and, indeed, all other portions of the specific descriptions, must in all cases be taken as applying to the *female*, unless otherwise stated.

Monoculus aurantius, Jurine, Hist. des Monocles, p. 173, pl. xviii. figs. 5–12.
—— *ruber*, Idem, ibidem, p. 172, pl. xviii. figs. 3, 4.

Valves oblong, subreniform, narrowed in front. Anterior extremity narrow, bordered by a flattened encircling lamina; posterior broad and well rounded. The ventral margin is straight or slightly sinuated; the dorsal arched, highest at its posterior third. Seen from above, the carapace is oblong, ovate, tapering to the anterior extremity, which is acutely pointed, the right valve being considerably overlapped by the left. Front view ovate, the suddenly compressed anterior margins projecting sharply forward. The surface is indistinctly granular, and finely punctate. Colour ochreous yellow, marked with bands and blotches of deeper orange. Near the anterior third of the dorsum there is frequently a conspicuous deep-brown or black spot, marking probably the position of the eye. The arrangement of the antennal setæ is precisely like that of *C. virens*,—the upper antenna bearing nine long and several shorter plumose filaments; the lower five, which reach but slightly beyond the apices of the claws. Four much shorter and mostly non-plumose setæ rise from the middle of the fourth joint, and reach not very much beyond the bases of the claws. These are found in all members of the genus. Setæ of the abdominal rami four, the two shorter ones being much longer than those of *C. fusca* or *C. virens*. The anterior portion of the shell is not unfrequently studded with a number of minute tubercles, which along the margin are gathered into a regular row of from twenty to thirty (fig. 21), producing an appearance as of a finely crenated or serrated border. The *marginal* row of tubercles is present, however, only on the right or smaller valve, which is provided internally with a narrow laminar plate (fig. 22), and is received within the overlapping and perfectly simple margin of the left valve. The posterior margin is also occasionally, but less frequently, tuberculated in a similar manner.

Length $\frac{1}{17}$ in., height $\frac{1}{30}$ in.

C. incongruens seems to be one of the less common species of this genus. It has been found in Kent and Essex by Professor T. Rupert Jones, at Blackheath, Windsor, and Dover by Dr. Baird, in the island of Cumbrae and in a lagoon on the Ayrshire coast by Mr. D. Robertson, in the county of Durham and in the Isle of Arranmore (Galway) by myself. It has a wide range on the continent, being mentioned by various authors as occurring in Switzerland, Germany, Norway, and Sweden.

My figures and description of this species were completed before I became acquainted with the memoir of Fischer contained in the 'Transactions of the Munich Academy;' and it is satisfactory to find that the observations of that author as to the distinctive characters of *C. aurantia* are quite in unison with my own. Dr. Fischer, however, assigns a specific rank to *C. rubra*, Jurine, almost entirely on the ground of the want of tuberculation of the carapace, at the same time admitting that the subject wants investigation, and that the relations between *C. fusca*, *C. aurantia*, and *C. rubra* are far from being clearly made out *. From what has been said above, it will be seen that I regard the two former species as distinct, not only from characters afforded by the carapace, but

* Es muss übrigens erst weitere Beobachtung lehren, ob nicht Uebergangsformen zwischen *C. aurantia*, *fusca* und *rubra* stattfinden, und sie alle drei nur als eine Species zu betrachten sind, da ihr Körperbau durchaus keine wesentliche Verschiedenheit wahrnehmen lässt."

by the animal itself. And I feel no hesitation in uniting *C. aurantia* and *C. rubra*, as all the gatherings I have seen contain both tuberculated and non-tuberculated specimens.

3. Cypris virens (Jurine). (Plate XXIII. figs. 23–32, and Plate XXXVI. fig. 1.)

Monoculus virens, Jurine, Hist. des Monocles, p. 174, pl. xviii. figs. 15, 16.
Cypris tristriata, Baird, Brit. Entom. p. 152, t. xviii. figs. 1, 1*a–i*, 2, 3.
—— *virens*, Lilljeborg, Crust. ex ord. tribus, p. 117, tab. viii. fig. 16, tab. ix. figs. 4, 5, tab. x. figs. 23–25, tab. xii. fig. 5, tab. xix. fig. 8, tab. xxvi. fig. 8.

Valves oblong, reniform; the extremities rounded and nearly equal. Dorsal margin evenly arched, highest in the middle; ventral gently sinuated. Seen from above the shell is oblong, ovate, pointed in front, rounded and narrow behind. End view broadly oval. The surface is smooth or slightly pubescent and mostly marked with minute and closely set puncta. The colour varies from a light greenish drab to a grass-green, varied with striæ of a deeper hue running obliquely across the valves from above downwards and backwards. The lucid spots are large, oblong, irregular in size and shape, but mostly somewhat crescentic or sinuous in outline. They are arranged in a group of about seven, near the centre of the valve, and point obliquely from above downwards and backwards. Besides the main group, isolated spots often occur on other parts of the valves, especially near the dorsal margin. The two claws of the postabdominal rami are unequal in length, and in fine specimens are serrated on their inner edge towards the apex. The short seta on the inner margin of the ramus is not far removed from the terminal claws.

Length $\frac{1}{14}$ in., height $\frac{1}{25}$ in.

Cypris virens is a very common species, met with mostly in small ponds, and apparently very generally distributed throughout Britain and the continent. Like *C. fusca* it seems seldom to inhabit lakes or large sheets of water. The hingement of this species is a good example of the normal structure of the joint in *Cypris*. It is figured at Plate XXIII. figs. 28, 29.

4. Cypris obliqua, n. sp. (Plate XXIII. figs. 33–38.)

Valves oblong, subreniform, not quite twice as long as broad. Extremities rounded and nearly equal. Dorsal margin gently and evenly arched, highest in the middle; ventral margin nearly straight, slightly sinuated near the front. The dorsal aspect is oblong-oval, broadest in the middle and tapering to the extremities, the anterior of which is more sharply pointed than the posterior. End view oblique, the right valve being on a higher plane than the left. Lucid spots nearly like those of *C. virens*. The surface of the shell is shining, very slightly hairy, and thickly impressed with rather large rounded puncta. Colour deep green or olive-brown, with three or four oblique darker bands. Postabdominal setæ stout and crowded together,—one long, two shorter and nearly equal, the uppermost very short.

Length $\frac{1}{22}$ in., height $\frac{1}{40}$ in.

I first took *C. obliqua* in Loughrigg Tarn, Westmoreland, in the summer of 1861, and for a considerable time thought it to be a very fine variety of *C. fusca*. Last year (1864),

however, I again met with it in the lakes at Rothley and at Belsay in Northumberland; Mr. Robertson has more recently taken it at Cumbrae; and it also occurs abundantly in a gathering taken by my brother, Mr. Alfred Brady, in a pond on Wandsworth Common.

In many respects this handsome species agrees with *C. virens*, but it is sufficiently distinct. The oblique end view (fig. 36) is especially characteristic. The shell is also much more strongly punctate than that of *C. virens*, the colour deeper, the setæ of the abdominal rami more crowded. The Westmoreland specimens are light olivaceous brown, those from Northumberland and Cumbrae are deep green; the Wandsworth specimens are more variable, and present an intermediate appearance. The figure and description of *C. elliptica* given in the 'Natural History of British Entomostraca' would apply tolerably well to the present species; but Dr. Baird has kindly compared one of my specimens of *C. obliqua* with those of *C. elliptica* preserved in the British Museum, and considers the two to be distinct.

5. Cypris elliptica, Baird.

Cypris elliptica, Baird, Trans. Berw. Nat. Club, ii. p. 152, 1846; Brit. Entom. p. 158, tab. xix. fig. 12.

"Shell nearly elliptical, of a light green colour, clouded with darker patches of the same colour on the sides of the shell. Valves glabrous, except round the edges, which are beset with long hairs. Filaments of inferior antennæ long. Pond at Highgate, July 1846."

I do not know this species, except from Dr. Baird's description quoted above.

6. Cypris punctillata, Norman. (Plate XXVI. figs. 1–7, and Plate XXXVI. fig. 11.)

Cypris cuneata, Baird, Proc. Zool. Soc. Lond. 1850, p. 255, pl. xviii. (Annulosa) figs. 22–24.
—— *punctillata*, Norman, Ann. & Mag. Nat. Hist. Jan. 1862, p. 43, pl. ii. figs. 11–14; and Trans. Tyneside Nat. Field Club, vol. v. p. 145, pl. iii. figs. 11–14.

Valves oblong, subovate, tumid. The anterior border is broad, well rounded, and armed on both valves with a series of eight sharp teeth; the posterior narrowed, rounded, and bears near the ventral angle of the right valve four or five spines, the lowest of which is much longer than the rest. Dorsal margin boldly arched, highest at its anterior third; ventral margin nearly straight, with a slight sinuation. Seen from above, the carapace is broadly ovate, pointed in front and rounded behind, the greatest breadth in the middle. The ventral aspect is marked by a conspicuous central fossa or sulcus formed by the depressed margins of the two valves. End view subpyramidal or cuneate, the height and width equal. Internally the front and hinder margins of the valves are produced into broad lamellar plates. Lucid spots about seven, oval, crowded, and placed obliquely near the centre of the valves. The surface is thickly beset with long hairs and marked by rather large closely set round pittings (fig. 6). Colour deep green.

Length $\frac{1}{13}$ in., height $\frac{1}{24}$ in.

First found at Duddingston Loch, Edinburgh, by Dr. Baird, and more recently by the Rev. A. M. Norman at Sedgefield, Durham.

This fine species was originally described by Dr. Baird from immature specimens, the name *cuneata* being meant to designate the lateral aspect of the shell. In the adult,

however, this term has no applicability; and I have therefore adopted Mr. Norman's specific name.

7. Cypris bispinosa, Lucas. (Plate XXVI. figs. 14–17.)

Cypris bispinosa, Lucas, Explorat. Scient. d'Algérie, Animal. Artic. Crustac. t. viii. figs. 7, 7 *a*, *b* (*fide* Baird).

Carapace oblong, subpyramidal, very tumid on the ventral surface, and gradually narrowing towards the dorsum. The ventral margin is elevated into a broadly rounded ridge which runs backwards, becoming gradually narrower and more sharply defined, until it ends, considerably behind the middle of the valve, in a sharp, curved, projecting spine: anteriorly the ridge curves upwards, and is gradually lost on the surface of the shell. The anterior margin is narrow and rounded. Dorsal margin arched, highest a little in front of the middle, where it is angular or gibbous, sloping equally to each extremity. The posterior extremity forms a slightly produced beak a little below the median line of the valve, thence sloping steeply upwards to the dorsal, and curving gently downwards to the ventral margin. Seen from above, the outline is tumid, oval, with acutely pointed extremities, the anterior of which is produced so as to form an "ogee" outline; the lateral spines are very conspicuous both in the dorsal and ventral aspects. End view triangular, base flattened, sides convex, lateral angles produced and rounded. Surface smooth, very finely punctate. Colour light green.

Length $\frac{1}{9}$ in., height $\frac{1}{16}$ in.

For specimens of this noble species (the finest British *Cypris*) I am indebted to the Rev. A. M. Norman, to whom it was forwarded some years ago by Dr. Lukis of Guernsey, who took it in a freshwater pool in that island. Dr. Baird identifies the specimens with *Cypris bispinosa*, Lucas, which was found in Algeria "in a little streamlet of fresh water flowing from the Boudigma."

8. Cypris gibbosa, Baird.

Cypris gibbosa, Baird, Mag. Zool. & Bot. i. p. 137, t. v. fig. 15, 1837; and Nat. Hist. Brit. Entom. p. 156, t. xix. fig. 8.

"Shell ovate, and much elevated on the upper margin, the centre exhibiting a large gibbosity or hump; sinuated underneath. The valves are smooth, except round the edges, which are beset with short fine hairs, are nearly opaque, and of a light green colour, the anterior extremity being paler than the other parts of the shell. Filaments of both pairs of antennæ beautifully plumose.

"*Hab.* Ditch near the Surrey Zoological Gardens, June 1836."

I know nothing of *C. gibbosa*, except from Dr. Baird's description.

9. Cypris tessellata, Fischer. (Plate XXIII. figs. 39–45.)

Cypris tessellata, Fischer, Mémoires des Savants Etrangers, St. Petersburg, vol. vii. p. 159, pl. x. figs. 1–5.
— *affinis*, Lilljeborg, De Crust. ex ord. trib. p. 116, pl. xi. figs. 8–14; Brady, Ann. & Mag. Nat. Hist. vol. xiii. (1864) p. 60, pl. iii. figs. 6–11, and Trans. Tyneside Nat. Field Club, vol. vi. p. 105, pl. ii. figs. 6–11.

Carapace oblong, tumid, broad in front, and tapering backwards from the anterior third.

Anterior margin broad, well rounded, and encircled by a narrow flattened lamina. Posterior extremity narrow, rounded. Ventral margin slightly sinuated in the middle. The dorsal margin has a gibbous elevation a little in front of the middle, from which it slopes steeply backwards and more gradually towards the front. Dorsal aspect oval, tumid, widest in the middle, and tapering equally towards the somewhat sharply pointed extremities. Anterior view nearly circular, the height being very slightly greater than the width. The surface of the shell is slightly roughened, presenting a scaly appearance, the result of a peculiar reticulated sculpturing. Colour olivaceous or brown. Postabdominal rami rather stout; the two terminal claws about equal in length; lateral setæ short.

Length $\frac{1}{25}$ in., height $\frac{1}{45}$ in.

I have found this species near Belsay, and in pools on the bents north of Seaton Sluice, Northumberland; at Fenham, near Newcastle, at Whitburn and Boldon Flats, near Sunderland, and near Cotherston, Yorkshire. It has been taken also by the Rev. A. M. Norman at Sedgefield and at Osterley Park, near Brentford.

C. tessellata is, in many cases, easily distinguished by the peculiar sculpturing of the valves, which, in fine specimens, and with good illumination under the microscope, resembles an exquisitely wrought pattern of filigree-work. The reticulations of which the ornament is composed are largest towards the extremities of the valves; across the middle of the carapace they are not very conspicuous, the shell-structure being there much more condensed. The junction of the reticulation of the extremities with that of the closer central band is shown in Pl. XXIII. fig. 43. It will be seen that the tendency to a radiate arrangement is continuous throughout. Occasionally the surface-marking is almost entirely absent, the shell being nearly as smooth as that of *Cypris fusca*; some trace, however, of the peculiar ornament is always visible.

Cypris tessellata appears to haunt only small grassy pools, where the water is considerably impregnated with organic matter. At least I know of no instance of its capture in lakes or large sheets of water.

My original reference of this species to *C. affinis*, Fischer, seems to have been an error. I had not at that time seen Fischer's monograph, and judged of the species from the figures given by Lilljeborg, which doubtless refer to the present species, but agree much more closely with Fischer's figures of *C. tessellata* than of *C. affinis*.

10. Cypris clavata, Baird.

Cypris clavata, Baird, Mag. Zool. & Bot. i. p. 137, t. v. fig. 16, 1837; Brit. Entom. p. 157, t. xviii. fig. 4;
Lilljeborg, Crust. ex ord. trib. p. 121, tab. xi. figs. 5–7.

"Shell oblong, narrower at posterior extremity than anterior, which is rather flattened, giving the shell the appearance of being club-shaped. The valves have the upper margin elevated, and the lower nearly straight. They are smooth and shining, but beset round the margin with short hairs; their colour is of a light grey, with an obscure dark-coloured ray running from the centre towards the posterior extremity, which again is distinctly marked with an orange-coloured spot. The antennæ and feet are short, compared with the size of the shell. The filaments of both pairs of antennæ are plumose.

This species approaches near to *C. crassa* of Müller, as described by him, but differs *in toto* from the figures which he gives of it.

"*Hab.* In a pond near Copenhagen Fields, July 1836" (*Dr. Baird*).

11. Cypris salina, Brady. (Plate XXVI. figs. 8–13.)

Cypris strigata, Baird, Brit. Entom. p. 157.

Valves reniform, compressed, about once and a half as long as broad. Extremities broadly rounded, nearly equal, and produced into flattened laminæ, which form a flange encircling nearly the whole shell. The ventral margin is slightly sinuate in the middle, and in the right valve is finely crenulated or toothed round each extremity: dorsal margin very strongly arched and highest rather in front of the middle. Seen from above, the carapace is compressed, oblong-ovate, acutely pointed in front and more obtusely behind, widest in the middle; there is a slight longitudinal sulcus on the hinge-line near the posterior extremity, formed by the juxtaposition of the incurved margins of the two valves. The contact-margins of the ventral surface are sinuous and remarkably prominent. End view ovate, compressed, the breadth equal to two-thirds of the height. Lucid spots similar to those of *C. fusca*. The surface of the valves is very finely punctate, and marked with a pattern of brown which may be described as follows:—Commencing under the middle of the dorsal margin a brown belt runs backwards, coursing nearly parallel to the circumference of the valve, and ceasing near the summit of the anterior border; on the central light-coloured patch thus nearly enclosed by a brown zone are two large, irregular, brown blotches, the hindermost of which sends upwards and forwards a prolongation connecting it with the marginal belt. Abdominal rami slender. Setæ three long and one short, all near together.

Length $\frac{1}{28}$ in., height $\frac{1}{45}$ in.

I first met with *C. salina* in a cooling-pond at Monkwearmouth Colliery, where it lives in great numbers together with *Cypridopsis aculeata*, *Cypris reptans*, and other species, in water which often reaches a temperature of 100° Fahr. and is so impregnated with earthy salts as to deposit a thick coating of carbonate of lime on the leaves of the plants which it supports. I have this year (1865) been fortunate enough to find the species in a second locality, namely, a small pool of somewhat brackish water, above high-water mark, in a salt marsh north of the river Coquet, below Warkworth. This habitat is particularly interesting, inasmuch as it leaves little doubt that the species here referred to must be the same as that discovered by Dr. Baird in a similar situation ("pool on seashore a little above high-water mark, at Thornton Loch, East Lothian, June 1835")—a matter hitherto doubtful, owing to the fact that the Scotch specimens have not been preserved. Mr. D. Robertson has also lately found this species in a pond liable to tidal overflow at Cumbrae.

I much regret that I have not been able to obtain examples of the form known to continental naturalists as *C. strigata* (Müller); for though the written description given by that author* accurately agrees with the British species, his figures are very far wrong.

* Müller's description of the carapace is very terse and expressive:—"*Testa* subovata, glabra, margine ciliata, ad

As Fischer has identified Müller's *C. strigata* with a species which seems to be very different from the present, I have thought it best to describe our British species under a new name.

** *Second foot without a claw, terminating in three moderately long and nearly equal setæ.*

12. Cypris gibba, Ramdohr. (Plate XXIV. figs. 47–54, and Plate XXXVI. fig. 2.)

Cypris gibba, Ramdohr, Magaz. d. Gesellsch. naturforsch. Freunde zu Berlin, 1808, ii. p. 91, t. iii. figs. 13–17 (*fide* Jones); Jones, Tertiary Entom. p. 15, pl. i. figs. 3*a–f*, and woodcut, fig. 1, p. 16.

Valves oblong, oval, nearly equal in height throughout, marked generally, but not always, by two deep transverse sulci extending from the anterior half of the dorsum to the middle of the valve. Extremities well rounded and nearly equal, fringed with hairs. Dorsal margin straight; ventral deeply sinuate in the middle. Seen from above, the carapace is oblong-ovate, narrowed in front and rounded behind, marked on the anterior half by one or more deep transverse sulci. End view subquadrate, keeled. Surface of the shell deeply and coarsely punctate (fig. 51), cream-coloured or light brown, sometimes nearly white. The shell is much thicker and stronger than that of any other *Cypris* with which I am acquainted. The second foot bears at the apex of the terminal joint three long setæ, two of which are nearly equal in length, the other considerably shorter: the penultimate joint has also two long and equal setæ springing from its inner margin; and another, somewhat shorter, rises from the apex of the second joint. Postabdominal rami flexuous, ending in two long and equal claws, and one very short seta; the marginal seta is unusually long, and is attached somewhat below the middle of the ramus. Eye very black and conspicuous.

Length $\frac{1}{28}$ in., height $\frac{1}{55}$ in.

Cypris gibba seems to be an almost ubiquitous species, but is liable to escape observation, owing to its habit of creeping on the bottom or imbedding itself in the mud or soft clay. It is nevertheless a true *Cypris*, the lower antennæ bearing a tuft of long setæ, and the second pair of jaws a branchial appendage. The armature of the second pair of feet is peculiar, and the shell-structure very different from that usually seen in this genus. The markings of the surface are very variable, some specimens being altogether devoid of grooving or tuberculation, while others are deeply uni-, bi-, or trisulcate. These variations do not seem to depend entirely upon age, though in young specimens the sulci and tubercles are, as a general rule, feebly developed or absent.

b. *Setæ of lower antennæ scarcely plumose, very short, not reaching to the apex of the terminal claws.*

13. Cypris trigonella, n. sp. (Plate XXV. figs. 41–44.)

Valves elongated, subtriangular, highest in the middle; height equal to more than

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aperturam sublinearis; valvulæ convexiusculæ, fuscæ, fasciis tribus albis, postica nempe lunata, media obliqua, antica arcuata; vel, si mavis, valvulæ albæ, margine dorsali cingulo fusco cinctæ, disco maculis duabus obliquis fuscis."

half the length. Extremities rounded and nearly equal, the anterior slightly narrowed. Ventral margin straight or slightly convex, dorsal arched, somewhat angular in the middle, where it is highest. The outline, as seen from above, is oval, tumid; width equal to half the length; extremities rounded and nearly equal; hinge-margins depressed posteriorly so as to form a longitudinal sulcus behind the centre of the carapace. End view circular. The surface is quite smooth and polished; colour sea-green, faintly mottled with patches of a deeper hue.

Length $\frac{1}{42}$ in., height $\frac{1}{80}$ in.

Cypris trigonella was found by the Rev. A. M. Norman amongst some freshwater shells collected by the late Mr. Barlee. From the character of the Mollusca with which it was associated (*Planorbis spirorbis* and *Limnæa peregra*) we may presume that it was taken probably in the south of England. The gathering contained several specimens of this *Cypris*, all of them agreeing in size and general character.

14. Cypris reptans (Baird.) (Plate XXV. figs. 10–14, and Plate XXXVI. fig. 4.)

Candona reptans, Baird, Trans. Berw. Nat. Club, i. p. 99, t. iii. fig. 11, 1835; and Brit. Entom. p. 160, tab. xix. figs. 3, 3*a*; Jones, Tert. Entom. p. 16, pl. i. figs. 7*a*–7*e*.

Cypris reptans, Lilljeborg, De Crustaceis, p. 123, tab. xi. figs. 21–23, tab. xii. figs. 7–9.

Candona virescens, Brady, Ann. & Mag. Nat. Hist. vol. xiii. p. 61, pl. iv. figs. 1–5, and Trans. Tyneside Nat. Field Club, vol. vi. p. 106, pl. iii. figs. 1–5.

Valves oblong, subreniform, compressed, unequal, the left being considerably the larger. The anterior and posterior margins are obliquely rounded, somewhat angular below, and nearly equal in height, the posterior somewhat the higher. Ventral border slightly sinuated, dorsal straight or very slightly arched. Seen from above, the carapace is compressed, oblong-ovate, widest in the middle, the anterior extremity pointed. End view ovate, prominently keeled in front and below. The surface is smooth and shining, and bears a few scattered hairs. Colour greenish with patches of lighter and darker hue, sometimes banded with orange or brown. The limbs and their terminal claws are all long and slender. Setæ of the lower antennæ short and rigid, sometimes slightly plumose, but mostly quite simple; the principal bundle rises from the apex of the second joint, and consists of four long and one short seta; an auxiliary brush springs from the middle of the joint, two on the outer, and one on the inner side: none of the setæ reach as far as the apices of the terminal claws. The postabdominal rami are long, slender, and serrated on the internal border; the two larger terminal claws are also serrated in a similar manner.

Length $\frac{1}{11}$ in., height $\frac{1}{25}$ in.

A very common species, and (excepting *C. bispinosa*) the largest of all the British freshwater Ostracoda. It often occurs in very great abundance, especially in the "cooling-ponds" of collieries, &c., where the temperature of the water is higher than ordinary.

In external appearance, and in habits of life, this species bears much more resemblance to the *Candonæ* than to the true *Cyprides*; but the structure of the lower

antennæ and the second pair of jaws renders it impossible to retain it in the position which it at first occupied as a *Candona*. The same remark applies also to the following species, *C. serrata*.

The species described by me in another place under the name *Candona virescens*, I now believe to be the young of *C. reptans*.

15. Cypris serrata (Norman). (Plate XXV. figs. 15–19, and Plate XXXVI. fig. 3.)

Candona serrata, Norman, Ann. & Mag. Nat. Hist. vol. ix. (1862) p. 46, pl. ii. figs. 1–6; and Trans. Tyneside Nat. Field Club, vol. v. p. 148, pl. iii. figs. 1–6.

Valves subtriangular, oblong, broad and rather squared in front, narrow and obliquely rounded behind. The ventral margin is nearly straight, the dorsal margin much elevated, and gibbous at the anterior third, sloping steeply towards each extremity. Anterior margin broad and only slightly rounded at the angles, armed along the lower half of both valves with a row of from eight to ten spines. The posterior margin is, in like manner, set with six or seven spines. Seen from above, the outline of the shell is oblong-oval, widest in the middle and tapering to each extremity. End view tumid, broad and rounded at the base, pyramidal at the apex. The colour of the shell is pale grey, marked with a central patch of lighter hue and two large patches of deep brown, which form a broad but interrupted zone round the central space. The depth, as well as the disposition, of the colours, however, is subject to considerable variation. Surface marked with impressed punctures, and beset with scattered hairs. Lucid spots seven, oblong, arranged irregularly near the centre of the valve, with their long axes nearly parallel with that of the shell. The most usual arrangement of the spots in this species, as also in *C. reptans*, is as follows:—a central row of three spots placed parallel to each other and transversely across the shell; two spots slightly in advance, and often coalescing below; the remaining two behind. A comparison of the figures (Pl. XXV. figs. 14 & 19) will show that this arrangement differs only slightly from that of *C. reptans*. The second joint of the lower antenna bears a brush of five simple non-plumose and very short setæ, springing from near its apex, and reaching not much beyond the middle of the third joint, which also bears four or five similar setæ reaching scarcely beyond the base of the terminal claws (Plate XXXVI. fig. 3). The postabdominal rami and their terminal setæ are long, slender, and without serratures. The second foot, both in this species and in *C. reptans*, bears a small hooked claw and setæ, just as in *C. virens*.

Length $\frac{1}{23}$ in., height $\frac{1}{40}$.

Hab. ***Cypris serrata*** was first described by the Rev. A. M. Norman from specimens taken by him at Sedgefield. I have myself taken it at Fardingslake, near Sunderland; and I am indebted to Mr. W. W. Stoddart for specimens from Ashley Brook, Bristol, where it seems to be very abundant.

c. *Setæ of lower antennæ plumose, unequal, two or three exceedingly long, the rest short. Second foot ending in three unequal setæ, one of which is excessively long.*

(Subgenus *Cypria*, Zenker).

16. Cypris compressa, Baird. (Plate XXIV. figs. 1–5, and Plate XXXVI. fig. 6.)

Cypris compressa, Baird, Trans. Berw. Nat. Club, i. p. 100, t. iii. fig. 16, 1835; Brit. Entom. p. 154, t. xix. figs. 14, 14 *a–c*; Lilljeborg, De Crust. ex ord. trib. p. 112, t. x. fig. 16–18.

—— *punctata*, Zenker, Anatomisch-system. Stud. über die Krebsthiere, p. 77, Taf. iii. A.

Valves compressed, reniform, about one-third longer than high. The dorsal margin is very much arched, highest in the middle; ventral margin straight or slightly sinuated; extremities broad and well-rounded. Outline, as seen from above, compressed, oblong, pointed in front, rounded behind; more than twice as long as broad. End view oval, equally rounded at base and apex; the height very much greater than the width. The shell is smooth and marked with distant but rather large puncta; colour light brown or straw-colour, transparent, with irregular opaque patches. The setæ of the lower antennæ are three very long (the apices of the claws reaching scarcely to the middle of the setæ), and three of about one-third this length. The biarticulate seta attached to the inner side of the second joint is considerably elongated, and has a distinctly tapering vesicular apex, which is also apparent in the other members of this section (see Plate XXXVI. fig. 5 *b*). The setæ attached to the inner side of the mandibular palp are very strongly plumose, and from their structure would almost appear to act as accessory respiratory organs (fig. 6 *n*)—a peculiarity which also exists throughout this section, and is sometimes, to a smaller extent, observable in other members of the genus. The mucus-gland of the male is terminated by a peculiar calyptra-like prolongation (fig. 6 *m*). The last joint of the second foot bears three setæ—one excessively long and more than equalling in length the three preceding joints, and two others much shorter, the shortest of all being slightly flexuous. The abdominal rami are rather short and stout, the terminal claws much curved, and bearing one or two teeth near the apices, the uppermost seta far removed from the rest and situate near the middle of the ramus.

Length $\frac{1}{48}$ in., height $\frac{1}{62}$ in.

C. compressa is a common species in ponds and ditches, often living where there is little or no vegetation. Dr. Zenker identifies this species with the *C. punctata* of Jurine; but the figures and description of the latter author are so vague, and in some respects so unlike *C. compressa*, that I cannot coincide in this view.

17. Cypris striolata, Brady. (Plate XXIV. figs. 6–10.)

Cypris striolata, Brady, Ann. & Mag. Nat. Hist. vol. xiii. (1864) p. 60, pl. iii. figs. 12–17; and Trans. Tyneside Nat. Field Club, vol. vi. p. 105, pl. ii. figs. 12–17.

Carapace broadly subovate; greatest height in the middle, equal to about two-thirds of the length. Dorsal margin strongly arched, sloping with a gentle curve toward the anterior, but with a bolder sweep towards the posterior extremity, ventral margin mostly somewhat convex. Anterior and posterior margins rounded, the former somewhat narrowed. Seen from above, the outline is compressed, oval, rather narrowed

in front, the greatest breadth equal to less than half the length. End view oval. The surface of the shell is highly polished and marked by closely set longitudinal anastomosing striæ (fig. 10). Colour dark brown. The anatomical structure agrees closely with that of *C. compressa*.

Length $\frac{1}{33}$ in., height $\frac{1}{50}$ in.

Hab. Greenlea Lough, Northumberland; Mickle Fell, Yorkshire; Connemara (*G. S. B.*); Lochmaben (*Sir W. Jardine, Bart.*); Peterhead Canal (*Mr. D. Robertson*).

The form described by me (*loc. cit.*) as a distinct species under the name of *C. striolata*, is noticed by Dr. Zenker as a variety of *C. punctata* (*compressa*); but the differences in size and surface-marking are so conspicuous as to form good specific characters; moreover the shells of the two species seem to retain their distinctive characters in all stages of growth. Dr. Zenker conjectures, but scarcely believes, that *C. striolata* may possibly be the very old state of *C. compressa*, inasmuch as he has never met with it except in the adult condition. I have, however, seen both young and old individuals, always retaining the distinctive characters of shell-sculpture &c. *Cypris prasina*, Fisch., and *C. exsculpta*, Fisch. (Munich Transactions, Band xvii.), bear some resemblance to the present species in their surface-marking; but the general form of the carapace seems to differ in both cases.

18. Cypris ovum (Jurine). (Plate XXIV. figs. 31–34, 43–45, and Plate XXXVI. fig. 8.)

Monoculus ovum, Jurine, Hist. des Monocles, p. 179, pl. xix. figs. 18, 19.

Cypris minuta, Baird, Brit. Entom. p. 155, tab. xviii. figs. 7, 8.

Valves subreniform, convex, greatest height equal to two-thirds of the length. Anterior and posterior margins rounded and nearly equal. Ventral margin distinctly sinuated near the middle; dorsal boldly arched, sloping more steeply behind than in front. Seen from above, the outline is ovate, widest behind the middle, broadly rounded behind, and tapering to a subacute extremity in front: greatest width equal to more than half the length. End view very broadly oval. Surface of the shell smooth or slightly punctate, sometimes slightly hispid. Colour yellowish or olivaceous brown, with irregular dark cloudings and transparent patches. The animal is almost precisely similar to that of *C. lævis*—two of the filaments of the second antennæ excessively long, the rest very short. The males, of which I have seen only one imperfect specimen, have the second jaws chelate.

Length $\frac{1}{55}$ in., height $\frac{1}{75}$ in.

This species is very common and widely distributed; but, as I for a long time supposed it to be a form of *C. lævis*, I am unable to specify exactly all the localities in which I have noticed it. The two species occur very generally in company with each other, but sometimes separately. The specimens from which my illustrations are drawn were taken at Axwell Park, in the county of Durham. Figs. 43–45 are more highly magnified representations of a form taken by me in the Loch o' the Lowes, Selkirkshire, perhaps the young of the present species, though the lower antennæ bore only *one* long seta.

19. Cypris lævis, Müller. (Plate XXIV. figs. 21–26, and Plate XXXVI. fig. 5.)

Cypris lævis, Müller, Entomostraca, p. 52, tab. iii. figs. 7–9.
Cypria ovum, Zenker, Anatom.-syst. Studien, p. 79, taf. iii. B.
Cypris ovum, Jones, Tertiary Entomostraca, p. 14, pl. i. figs. 4*a*, 4*b*; Lilljeborg, De Crust. ex ord. tribus, p. 113, tab. x. fig. 13–15.
—— ?*pantherina*, Fischer, Ueber das Genus *Cypris*, p. 163, tab. xi. figs. 6–8.

Carapace ovate, subglobose; greatest height equal to nearly three-fourths of the length. Dorsal margin very strongly arched, or even angular, highest in the middle; ventral margin straight or slightly convex. Extremities rounded and nearly equal. The dorsal aspect of the carapace is very broad, subglobose, pointed in front and very broadly rounded behind, broadest near the middle: length about one-third greater than the breadth. End view subcircular. Lucid spots four, quadrangular, crowded: three set transversely in front, and one behind. The shell is smooth and shining, distantly punctate; colour a transparent yellowish or olive-brown, clouded with patches of darker hue, which often form faint striæ (fig. 21) arranged as in *C. vidua*. These striæ, however, are mostly absent or reduced to one or two faint dorsal patches. The filaments of the upper antennæ are eight or nine in number. The lower antennæ have three excessively long setæ (Plate XXXVI. fig. 5), measuring more than twice the length of the apical portion of the antennæ, reckoning from the origin of the setæ to the extremity of the ungues. The postabdominal rami are rather stout, their claws sharply curved at the apices. The setæ of the second feet as in *C. compressa*.

Length $\frac{1}{44}$ in., height $\frac{1}{82}$ in.

20. Cypris cinerea, n. sp. (Plate XXIV. figs. 39–42, and Plate XXXVI. fig. 7.)

Carapace oval, tumid, higher in front than behind; greatest height equal to nearly two-thirds of the length. Anterior margin broad and well rounded, posterior narrowed and rather obliquely rounded. Ventral margin straight or very slightly incurved, dorsal forming a flattened arch and sloping more steeply behind than in front. Seen from above, the outline is rhomboidal or lozenge-shaped, the greatest breadth in the middle, and equal to more than half the length; from the middle the sides taper evenly toward the extremities, the anterior of which is acutely, the posterior obtusely pointed. End view very broadly oval, pointed above and below. The right valve considerably overlaps the left. Surface of the shell very finely and closely punctate, slightly pubescent; colour ash-grey. The second antenna has three setæ very long, the rest short; its claws, as also those of the first foot, are long, slender, and destitute of serratures. The terminal setæ of the second foot (Plate XXXVI. fig. 7) are very stout from the base to the middle, then suddenly constricted and tapering to the points. Postabdominal rami very stout; their claws short and stout; the lateral seta and that on the inner border of the ramus very short and slender.

Length $\frac{1}{35}$ in., height $\frac{1}{55}$ in.

Cypris cinerea has hitherto occurred to me only in one locality, a pool not far from the summit of Mickle Fell in Yorkshire, at an elevation of about 2000 feet. In the same gathering were *C. compressa*, *striolata*, and other species. It is very distinct from any

other British *Cypris*, and I cannot identify it with any of the numerous species described by continental authors.

21. Cypris Joanna, Baird.

Cypris Joanna, Baird, Trans. Berw. Nat. Club, i. p. 99, t. iii. fig. 8, 1835, and Brit. Entom. p. 155, t. xviii. fig. 5.

"Shell rounded, ovate, narrower anteriorly than posteriorly, of a brown colour, with an orange mark across the back of the shell and the lower margin. Shell beset all round with rigid hairs, and covered with minute black points or dots. Approaches the *C. pilosa* of Müller, but is smaller, and is otherwise distinguished from it by the orange mark across the back, and by not being glabrous, but marked all over with black, roughish-looking points. It is a little longer than *C. minuta*. *Hab.* Pool of water on one of the Lammermuir Hills, near Abbey St. Bathans, Berwickshire; August 1835."—*Dr. Baird.*

I have never found this species, nor seen specimens of it. Can it be a moorland form of *C. lævis* ?

Genus 2. Cypridopsis, Brady*.

Like *Cypris*, except that the postabdominal rami are rudimentary, consisting of two slender setiform prolongations (Plate XXXVI. figs. 9, 10), thickened below and rising together from a common base. The second feet are terminated by a short hooked claw, and two moderately long setæ.

The three species belonging to *Cypridopsis* have not much in external appearance to separate them from section *c* of the preceding genus; but the structure of the abdominal rami is of itself a character of sufficient importance to form a generic distinction. The characters of the second feet are the same as found in section *a* of the genus *Cypris*. The males have not yet been met with.

1. Cypridopsis vidua (Müller). (Plate XXIV. figs. 27–30, 46.)

Cypris vidua, Müller, Entomostraca, p. 55, tab. iv. figs. 7–9; Baird, Brit. Entom. p. 152, t. xix. figs. 10, 11; Lilljeborg, De Crust. ex ord. trib. p. 111, tab. x. figs. 10–12.

—— *sella*, Baird, Brit. Entom. p. 158, t. xix. figs. 5, 5*a*.

Monoculus vidua, Jurine, Hist. des Monocles, p. 175, pl. xix. figs. 5, 6.

Shell ovoid, very tumid: greatest height in the middle, equal to two-thirds of the length; extremities rounded, the anterior much the broadest. Dorsal margin arched and highest in the middle; ventral margin very slightly sinuated. Seen from above, the carapace is ovate, exceedingly tumid, narrowed in front, and broadly rounded behind, widest a little behind the middle; length about one-third longer than the breadth. The end view is very broad in proportion to its height, the diameter from side to side being nearly one-fifth more than that from base to apex. The setæ of the lower antennæ reach much beyond the apices of the claws. The short articulate appendage of the third joint bears at its extremity a very distinct subovoid hyaline vesicle (fig. 46). The limbs are uniformly very robust. The shell is smooth and mostly marked with small impressed puncta: colour dull white, with three black bands running transversely from the dorsal margin to the middle of each valve. The anterior band is the

* Intellectual Observer, vol. xii. p. 117.

narrowest, the hindermost the broadest. On the ventral aspect the bands are not visible. The middle and posterior bands are sometimes connected along the hinge-margins by a broad longitudinal band of the same colour (see figs. 27, 28). In this condition it is *Cypris sella* (Baird).

Length $\frac{1}{45}$ in., height $\frac{1}{75}$ in.

C. vidua is a common and widely distributed species. I have specimens from many different localities, ranging from Kent to Dumfriesshire.

2. CYPRIDOPSIS ACULEATA (Lilljeborg). (Plate XXIV. figs. 16–20, and Plate XXXVI. fig. 10.)

Cypris aculeata, Lillj. De Crust. ex ord. trib. p. 117, t. xi. figs. 15, 16; Norman, Ann. & Mag. Nat. Hist. vol. ix. (1862) p. 44, pl. ii. figs. 7–10, and Trans. Tynes. Nat. F. C. vol. v. p. 147, pl. iii. figs. 7–10.

Valves broadly reniform or subtriangular, convex; greatest height in the middle, equal to two-thirds of the length. The anterior and posterior margins are well rounded, the latter being somewhat the broader of the two. Ventral margin deeply sinuated in the middle; dorsal very boldly arched, almost angular in the middle. Seen from above, the carapace is ovate, pointed in front, and rounded behind, broadest in the middle; width equal to half the length. The end view is ovate, rounded at the base and rather pointed above. The whole surface of the shell is thickly pitted and beset with stiff hairs, mingled, more particularly near the dorsum, with strong, pointed spines (fig. 20). Colour bluish green or dirty brown. The limbs are altogether very robust. Setæ of the lower antennæ about equal, and reaching much beyond the apices of the terminal claws. The mandibular palp bears four strongly plumose setæ (much like those of *Cypris compressa*), the uppermost of which is broad and somewhat lancet-shaped. The terminal claw of the first foot is strongly curved, and serrated for a short distance near the apex; the serratures, however, do not extend quite to the point of the claw.

Length $\frac{1}{45}$ in., height $\frac{1}{75}$ in.

Hab. Gravesend, in brackish water (*Prof. T. Rupert Jones*); brackish water in Suffolk and near Grimsby (*Mr. E. C. Davison*); Cowpen Marshes, Durham (*Rev. A. M. Norman*); Monkwearmouth Colliery Pond, Hylton Dene, and Warkworth (*G. S. B.*). In a pond a little above high-water mark, Cumbrae (*Mr. D. Robertson*).

This pretty species, though apparently much restricted in its range of habitat, occurs very abundantly in congenial situations, preferring, like *Cypris salina*, water impregnated with saline matters. Of the eight localities here mentioned, seven were slightly brackish in character, and the other was, as already noted (*C. salina*), loaded with salts of lime. At Monkwearmouth Colliery it occurred in company with *Cypridopsis vidua*, *Cypris reptans*, *C. salina*, *Daphnia vetula*, &c.; at Hylton Dene with *C. gibba*, *C. compressa*, *Candona candida*, *Mysis vulgaris*, *Palæmon varians*, *Corophium longicorne*, and many freshwater plants and animals; at Warkworth with *Cypris salina*, *Cytheridea torosa*, *Chydorus sphæricus*, and *Daphnia vetula*; at Gravesend with *C. gibba*, *Candona candida*, *Cytheridea torosa*, and *Crangon vulgaris*.

The only brown specimens I have seen were from Gravesend, Grimsby, and Warkworth; these have the appearance of being coloured by dirty water.

3. Cypridopsis villosa (Jurine). (Plate XXIV. figs. 11–15, and Plate XXXVI. fig. 9.)

Monoculus villosus, Jurine, Hist. des Monocles, p. 178, pl. xix. figs. 14, 15.
Cypris Westwoodii, Baird, Brit. Entom. p. 156, pl. xix. fig. 9.
—— ? *elongata*, Baird, Brit. Entom. p. 156, pl. xix. fig. 6.

Carapace compressed, oblong, reniform; height equal to more than half the length. The dorsal margin is boldly arched, highest in the middle; the ventral margin deeply incurved along its entire length. The anterior border is broad and rounded, the posterior somewhat produced, forming an obscure angle inferiorly. Outline, as seen from above, compressed, oval, pointed in front and rounded behind; about twice and a half as long as broad. End view oval, rounded at the base, pointed above. Surface of the shell covered with long, fine hairs. Colour light grass-green.

Length $\frac{1}{40}$ in., height $\frac{1}{75}$ in.

This is one of the less common species of freshwater Cypridæ. It has been found at Yetholm Loch, Roxburghshire, by Dr. Baird; at Sedgefield, Durham, by the Rev. A. M. Norman; in moorland pools near Easedale Tarn, Westmoreland, in a pool near Cotherston, Yorkshire, in Belsay East Lake and near Crag Lake, Northumberland, and in ponds at Silksworth and Fulwell, near Sunderland, by myself; also by Mr. D. Robertson in a pool near Banff.

The nearest ally of this species is *C. aculeata* (Lillj.). *C. villosa*, however, is much less tumid, the ventral margin much more deeply arched, the dorsal margin not rising to a point, while the surface of the shell is destitute of spines, and clad with much less rigid hairs than those of *C. aculeata*.

Cypris elongata, Baird, appears to me to be the young form of *C. villosa*.

Genus 3. Paracypris, G. O. Sars.

Shell smooth, compact, much higher in front than behind. Upper antennæ seven-jointed, shortly setiferous; lower stout, terminating in four strong curved claws, three of which are nearly equal in length, the other considerably shorter, antepenultimate joint bearing at its base a pedicellated hyaline vesicle. Mandibles terminating in five or six rather long teeth, and bearing a four-jointed palp, from the basal joints of which springs a narrow branchial appendage. "The external lobe or palp of the first pair of jaws linear, scarcely broader than the rest. Second pair of jaws provided with a branchial appendage; the palp elongated, conical and inarticulate"*. Last pair of feet similar to the first in form and size; both pairs five-jointed, and terminating in a long

* I have had no opportunity of verifying these particulars, most of my British specimens having come into my hands either as mere empty shells, or containing, at best, mutilated animals. The portion of the generic definition contained within inverted commas is, therefore, quoted from G. O. Sars; and I may here, once for all, state that where similar quotations are made in subsequent parts of this memoir they are derived from the same source, and are inserted for the same reason. The drawings, however, it may be proper to say, have been in all cases done by myself, direct from nature; and through the kindness of Herr G. O. Sars in furnishing me with Norwegian specimens, I have, in some cases, been able to give illustrations of the anatomy of species which could not have been derived from British examples. These remarks apply almost exclusively to the very *rarest* species; but, when practicable, I have always preferred to draw from native specimens, and have never used foreign ones when there could be the least doubt as to their identity.

curved claw; the last pair armed also with a short seta, which is directed upwards. Postabdominal rami large, armed at the extremity with two strong curved claws, and a short slender seta; the posterior margin also bearing two long setæ. One eye.

This genus approaches very closely to the freshwater *Cyprides*, especially in the structure of the second pair of jaws, which have a distinct branchial appendage and a conical palp, ending in three setæ, as in *Cypris*, *Candona*, &c. From the genus *Candona* it is clearly separated by the presence of the branchial plate of the second maxillæ; and Sars observes that the second pair of feet, which in *Cypris* and *Candona* are slender, much bowed, and constantly tucked up within the valves, are here stronger and, during the movement of the animal, may often be seen partially to extrude themselves. The shell partakes much more of the characters of the Cytheridæ than of the Cypridæ, being very hard and compact in structure. The short antennal setæ are evidently adapted for a crawling motion in or on the mud, rather than for swimming. The only British member of the genus is

PARACYPRIS POLITA, G. O. Sars. (Plate XXVII. figs. 1–4, and Plate XXXVIII. fig. 2.)

Paracypris polita, Sars, Oversigt af Norges marine Ostracoder, p. 12.

Scandinavian type. DISTRIBUTION: *Recent*—Norway, Great Britain. *Fossil*—Scotland, Norway, glacial.

Seen from the side, the carapace is elongated, siliquose, or subtriangular; greatest height at the anterior third, and equal to more than one-third of the length. Anterior extremity evenly rounded, posterior much attenuated, pointed. Dorsal margin arched in front, and sloping steeply behind; ventral concave along the greater portion of its length. Seen from above, it is much compressed, oval, not quite four times as long as broad, greatest breadth in front of the middle; extremities obtusely pointed. End view oval. Shell smooth and polished, almost destitute of hairs: colour yellowish white. The setæ of the upper antennæ are nearly equal in length to the six preceding joints, sixth joint longer than the rest. The antepenultimate joint has at its inner apical angle two setæ; and from its basal portion springs a fine tubular filament, which ends in a pyriform sac or vesicle. The postabdominal rami are gently curved, the exterior claw somewhat longer than the other. Male unknown.

Length $\frac{1}{22}$ in., height $\frac{1}{55}$ in.

Hab. In moderate depths of water, 3–30 fathoms. Channel Islands, and Loch Alsh, Hebrides (*Mr. Jeffreys*); Shetland (*Mr. Waller* and *Mr. Robertson*); Tobermory, at roots of *Laminariæ* (*Rev. A. M. Norman*).

In no British specimens have I seen the purple or reddish markings which are mentioned by Sars as characterizing the shell of this species, and which are quite distinct in specimens which I have received from him. But it is more than probable that the colours may have been destroyed, as well as the animal itself, by the prolonged drying amongst sand or mud to which my specimens have been subjected. The curious "hyaline vesicle" attached to the second antenna, which occurs in this genus and also in *Pontocypris*, is an organ the use of which it is difficult to conjecture. The vesicle itself appears sometimes as if filled with a granular matter; and the pedicle is, I think, tubular; but I have been unable to trace it further than its attachment to the antennal

joint. It occupies a position similar to that of the biarticulate seta which is uniformly present in the freshwater Cypridæ; and I have noticed that in some of these (e. g. *Cypridopsis vidua*) the extremity of the seta forms a sac somewhat similar, but not so largely developed.

Genus 4. Notodromas, Lilljeborg.

(*Cyprois*, Zenker; *Newnhamia*, King.)

Carapace of very different shape in the male and female. Two eyes. Antennæ similar to those of *Cypris*; the superior composed of seven, the inferior of six joints. Setæ of the inferior antennæ reaching beyond the apex of the terminal claws. Second pair of jaws without a branchial appendage, pediform in the male. Abdominal rami long and slender. Mucus-gland of the male large, beset with very numerous closely set whorls of stout rigid setæ. Copulative organs of very complex structure.

The genera *Cyprois* (Zenker) and *Newnhamia* (King) seem to be identical, or nearly so, with *Notodromas* (Lilljeborg). The torose, tuberculated condition of the valves of *Newnhamia* cannot be considered as supplying a distinctive generic character; while the general contour of the carapace and the "boat-like plate" of the ventral surface are remarkably in accordance with the English species *N. monachus*. A more important difference (if borne out by further observation) is the presence in *Newnhamia* of a branchial appendage to the second pair of jaw-feet. Mr. King states that this is present in *all* the Australian Cypridæ, though he does not specially mention it in his definition of the genus or species of *Newnhamia*. But from the more general statement, we are left to infer the presence of this appendage. Mr. King describes *Newnhamia* as possessing also transparent ocular tubercles.

Notodromas monachus (Müller). (Plate XXIII. figs. 1–9, and Plate XXXVII. fig. 3.)

Cypris monacha, Müller, Entomostraca (1785), p. 60, tab. v. figs. 6–8; Baird, Natural History of British Entomostraca, p. 153, tab. xviii. fig. 6.

Monoculus monachus, Jurine, Hist. des Monocles, p. 173, pl. xviii. figs. 13, 14.

Notodromas monachus, Lilljeborg, De Crustaceis ex ord. tribus, p. 95, tab. viii. figs. 1–15, tab. xii. figs. 1, 2, tab. xxv. fig. 16.

Male.—Carapace obliquely subquadrangular, greatest height equal to two-thirds of the length, situated in the middle. Anterior margin broad, rounded at the angles, and expanded into a flattened lamina or flange. Ventral margin straight for about two-thirds of its length, then bending upwards at an obtuse angle. Dorsal margin arched, almost angular in the middle, whence it slopes steeply to the anterior border, and with a bold curve towards the posterior extremity, joining the ventral margin at an acute angle. Seen from above, the carapace is ovate, pointed in front, and rounded behind; the greatest breadth in the middle. The ventral surface is bounded by two conspicuous, elevated, arcuate ridges (figs. 3, 6), one on each valve, which together enclose a flattened lozenge-shaped area. Parallel to the contact margin of each valve runs another straight but much less conspicuous ridge, which, towards the front, curves outward, and joins the external ridge at an acute angle, the union of the two forming a slight elevation (fig. 6*a*),

from which a single ridge runs forward, gradually merging in the flattened encircling flange of the anterior border. Seen from the front, the shell is subquadrangular, the sides convex, but flattened, the dorsum forming a flattened arch; the ventral border perfectly flat, and bounded by the projections of the outermost ventral ridges; the inner ridges form also conspicuous projections, which run obliquely upwards and inwards towards the flattened anterior flange. Lucid spots about six, oblong and irregularly placed, their long diameters pointing transversely across the valve. Surface of the shell smooth and shining, marked by fine impressed lines, forming a pattern similar to the imbrication of fish-scales. Colour pale greenish or white, transparent, with large and irregularly spread patches of deep olive-green or black.

Female.—Subquadrangular. Anterior border flattened, flanged, forming with the ventral margin a well-marked angle; rounded above. Dorsal margin boldly arched, highest at the posterior third, whence it sweeps round with a deep curve to the postero-ventral angle. Ventral margin straight, slightly rising behind, and terminating in a flattened squamous plate, which projects backwards, with the appearance of a spine. The other aspects are similar to those of the male shell, except that the ventral surface of the left valve has at the posterior extremity of its contact margin a flattened squamous plate (fig. 6*b*), which is received into a corresponding depression of the opposite valve.

The mandibles have a structure similar to those of other Cypridæ; but the branchial appendage rises from the lower instead of the upper border of the palp* (Plate XXXVII. fig. 3*c*). The second pair of jaws have no branchial appendage. In the female (fig. 3*e′*) they possess a large subconical palp, which terminates in two setæ. In the male they are pediform; the last joint of the right side (fig. 3 *e″*) is much elongated, and terminates in a short seta and a long flexuous claw, which is composed of a strong midrib, with lateral membranous expansions; the left jaw has its last joint (fig. 3 *e‴*) shorter and wider, its inner margin having two strongly marked angles, one a little above the middle, the other near the lower extremity; the outer margin is flexuous, and is produced laterally near its distal extremity into an acutely angular projection; the terminal claw is falciform: the penultimate joint of both sides bears at its apex a dense tuft of short setæ. The first foot in both sexes terminates in three curved claws, the central one being much the strongest and longest (fig. 3*f′*, *f″*). The second foot is slender and curved upward, like that of *Cypris*, terminating in three equal setæ, the second and third joints also giving off each a long apical seta (fig. 3 *g*). The "glandula mucosa," or testis of the male, consists of a central cylinder, closely beset with radiating filaments (fig. 3*l*), arranged in 50–60 transverse rows, the whole organ being imbedded in a sort of glairy matrix. The two glands are connected each by an efferent duct with the "*bursa copulatrix*," an organ of very complicated structure (fig. 3*k*), and consisting essentially (so far as I can make out) of a much convoluted canal (? *vesicula seminalis*), an intromittent organ or *penis*, and two hooked appendages. The whole organ is very dense in structure, consisting probably of chitine, deep brown in colour, and, with the

* I at first thought that this appearance must arise from distortion, the parts of the animal having probably got twisted during dissection and manipulation under the microscope; but in order to correct any error of this kind, I examined several animals, and always with the same result.

"glandulæ mucosæ," constitutes a very considerable portion of the contents of the male carapace. It should be noted that the "*bursa copulatrix*," as well as the testis, is a *double* organ, one on each side of the median line. The two bursæ lie closely in apposition, but are not in organic connexion except at the upper margin, where they are held together by a ligamentous tissue. The postabdominal rami are long and slender, and terminate in two unequal slender claws and a short seta.

Length $\frac{1}{24}$ in., height $\frac{1}{32}$ in.

Notodromas monachus is generally distributed throughout Britain, occurring often in very great abundance. It seems to delight chiefly in grassy pools, or lakes where there is a profusion of vegetation. Mr. Norman tells me that in sunny weather he has often seen it floating on the surface of the water in considerable numbers. Dr. Baird gives the neighbourhood of London and Rugby as localities for this species. It has been taken by Mr. Norman and myself in many places in the counties of Northumberland and Durham; and I have also met with it frequently in the lakes of Selkirkshire, Dumfriesshire, and Kirkcudbrightshire. Mr. Robertson has taken it in the island of Cumbrae.

The following remarks of Mr. King* relative to the habits of the Australian species, "*Newnhamia fenestrata*," are very interesting when considered in reference to those of *N. monachus*:—"This very common but interesting species lives almost wholly near the surface of the water, its boat-like plate enabling it to walk along the under surface, while its eyes, directed downwards, give immediate notice of the approach of an enemy. When alarmed, it immediately sinks to a little distance, and then swims off, only coming to the surface when all becomes tranquil. The hand passed over the water near the surface, so as to intercept the light, or the surface being disturbed by the slightest breath, instantly alarms them. They are the most active when the sun is shining; and often a whole troop of them may be noticed swimming round and round, and in and out, with a most lively and graceful motion, about an inch beneath the surface, in some spots more favoured than others by the warmth of the sun."

Genus 5. Candona, Baird.

Like *Cypris*, except that the lower antennæ possess no tuft of setæ, and that the second pair of jaws are destitute of a branchial appendage. Setæ of the upper antennæ short. Above the base of the postabdominal rami there is a short seta springing from an enlarged base, somewhat similar to, but smaller than, that of *Pontocypris* (see Plate XXXVII. fig. 2 *i*). The animals belonging to this genus have no swimming-power, and are very sluggish in their movements, crawling leisurely on the bottom, or on the stems of water-plants, or sometimes burying themselves in the mud.

1. Candona albicans, Brady. (Plate XXV. figs. 20–25, and Plate XXXVI. fig. 12.)

Candona albicans, Brady, Ann. & Mag. Nat. Hist. vol. xiii. (1864) p. 61, pl. iv. figs. 6–10, and Trans. Tyneside Nat. Field Club, vol. vi. p. 107, pl. iii. figs. 6–10.

Valves oblong, subreniform, nearly equal in height throughout, the left considerably overlapping the right; height equal to more than half the length. Anterior and pos-

* Proc. Roy. Soc. Van Diemen's Land, vol. iii. part 1.

terior extremities rounded gradually towards the short and straight dorsal margin, suddenly towards the ventral margin, which is more or less deeply sinuated. Seen from above, the outline is compressed, ovate, oblong, pointed in front and rounded behind, the sides nearly parallel, width equal to much more than one-third of the length. End view broadly ovate, obtusely pointed above, rounded below. The shell is covered with rather large and closely set angular puncta, and bears a few scattered slender hairs round the anterior and posterior margins. Lucid spots six, irregularly quadrate (fig. 24). Colour opaque white, uniform or with pellucid patches.

Length $\frac{1}{45}$ in., height $\frac{1}{80}$ in.

C. albicans has been taken abundantly by the Rev. A. M. Norman in a small grassy pond at Sedgefield (Durham), by Mr. D. Robertson in the Glasgow and Paisley Canal, and by myself near Sunderland. It is nearly allied to the following species, but smaller, more profusely punctate, and considerably less tumid.

2. Candona lactea, Baird. (Plate XXIV. figs. 55–58.)

Candona lactea, Baird, Proc. Zool. Soc. Lond. 1850, p. 255, pl. xviii. (Annulosa) figs. 25–27.

Lateral view oblong, subquadrangular, nearly equal in height throughout; height equal to half the length. Extremities obliquely rounded, equal. Dorsal margin straight, ventral gently sinuated. Seen from above, the shell is oblong-ovate in outline, somewhat pointed in front; greatest width about the middle, and equal to half the length; the left valve considerably overlapping the right. End view suborbicular, the width slightly less than the height. Surface smooth, finely and sparingly punctate. Colour greyish white.

Length $\frac{1}{38}$ in., height $\frac{1}{75}$ in.

Hab. "Freshwater pond at Charing, Kent; and Regent's Park—*T. Rupert Jones, Esq.*" (*Dr. Baird*)

3. Candona compressa (Koch). (Plate XXVI. figs. 22–27.)

Cypris compressa, Koch, Deutschlands Crustaceen, H. 21. pl. xvii. (*fide* Lilljeborg).
Candona compressa, Lilljeborg, De Crust. ex ord. tribus, p. 129, tab. xxvi. figs. 1–3.
Cypris setigera, Jones, Tertiary Entomostraca of England, p. 12, pl. i. figs. 6*a*–6*d*.

Lateral aspect compressed, subreniform, higher behind than in front; greatest height equal to more than half the length. Anterior extremity obliquely rounded, sloping steeply above to join the short and straight dorsal margin; the posterior broad and well rounded. Ventral margin incurved in front of the middle. Outline, as seen from above, compressed, oval, acuminate in front, widest in the middle, width equal to less than half the length. End view oval. Surface smooth, milk-white, thickly covered with very short and fine hairs, and often marked with a minutely reticulated pattern. Lucid spots six, arranged in two transverse rows.

Length $\frac{1}{30}$ in., height $\frac{1}{55}$ in.

Candona compressa was taken by Mr. D. Robertson in the Glasgow and Paisley Canal; and a single valve, apparently belonging to the same species, occurred amongst Ostracoda found by Dr. Alcock in shell-sand from Roundstone. The peculiar reticulated

ornament of the shell is not noticed by Lilljeborg, and is, indeed, visible only in specimens of moderate age, while they remain free from opacity.

4. Candona candida (Müller). (Plate XXV. figs. 1–9, Plate XXXVI. fig. 13, and Plate XXXVII. fig. 1.)

Cypris candida, Müller, Entomostraca, p. 62, tab. vi. figs. 7–9; Zenker, Anat.-syst. Studien, p. 76. Taf. i. figs. 1–10.
Monoculus candidus, Jurine, Hist. des Monocles, p. 176, pl. xix. figs. 7, 8.
Candona lucens, Baird, Brit. Entom. p. 160, tab. xix. fig. 1.
—— (?) *similis*, idem, ibidem, p. 162, tab. xix. figs. 2, 2*a*.
—— *candida*, Lilljeborg, De Crust. ex ord. trib. p. 127, tab. xi. figs. 19, 20, tab. xxv. figs. 13–15; Jones, Tertiary Entom. p. 19, pl. i. figs. 8*a*–8*f*, 5*a*, 5*b*.

Valves oblong, lower in front than behind, reniform in the male, subtriangular in the female; greatest height equal to more than half the length. Anterior margin rounded and narrow. Posterior margin obliquely rounded and produced into a more or less prominent angle inferiorly. The ventral margin is only slightly sinuated in the young and in adult female specimens, but in old examples and in the adult male is deeply sinuated at the anterior third, and bulges considerably behind (figs. 7, 8). The dorsal margin is highest at the posterior third, from which it slopes, in a flattened arch, to the front. The outline, as seen from above, is oblong-ovate, pointed in front, and rounded behind, widest in the middle; greatest width equal to half the length. End view broadly ovate, somewhat angular at the base, and rounded above. Lucid spots six, oblong, their long diameters nearly parallel to that of the shell, arranged in two lines—an anterior transverse row composed of four spots, and a posterior row of two, placed directly behind the lower spots of the front row. Surface of the shell smooth, pearly or yellowish white, with darker yellow cloudings toward the dorsal margin. Young specimens are regularly oval, and present none of the angulation characteristic of the adult. The setæ of the upper antennæ are very short, and arranged as in *Cypris*. The claws of the lower antennæ are long and slender. The mandibles and maxillæ do not differ from those of *Cypris*, except in the absence of the branchial appendage of the second pair of maxillæ. The palp of the second jaw in the male is pediform, ending in one strong curved claw and two shorter ones, which spring from the inner border of the last joint; the central part of the joint has a curious oval depression, perhaps indicating a muscular attachment; the palp in the female is subconical, and ends in three slender setæ. The second foot terminates in three setæ, two moderately long, the other rather shorter; the penultimate joint bears one apical seta. Postabdominal rami slender; the two terminal claws slender, and nearly equal in length; one short posterior seta, and one on the inner margin of the ramus below the middle. Testis composed of a central, cylindrical, transversely striated axis, bearing seven whorls of tapering filaments. The spermatozoids seem to be composed of two filaments, either spirally intertwined or laid side by side (see Plate XXXVII. fig. 1*t*). Some large adult specimens, collected by Professor T. Rupert Jones in slightly brackish water at Gravesend, exhibit near the posterior extremity of the shell a peculiar reticulated pattern (fig. 9), very similar to that of

Cytherideis nobilis (Brady)*, a marine species found on the coast of Crete. Curiously enough, this marine form is also not unlike *Candona candida* in shape and general appearance.

Length $\frac{1}{25}$–$\frac{1}{16}$ in., height $\frac{1}{46}$–$\frac{1}{30}$ in.

The males of *C. candida* are much more abundant than those of any other species of the family; they appear, indeed, to be almost as plentiful as the females. When their scarcity in other species is borne in mind, this is a very remarkable fact: whether it is constantly the case, or only occurs at some particular seasons, or in favourable localities, I cannot at present confidently state. *C. candida* may be taken as the type of the genus *Candona*; and the anatomical description given above will apply in its main features to the other members of the genus.

It is an exceedingly common species, being found almost everywhere, in ponds, lakes, and slowly running streams, and even in brackish water.

5. Candona detecta (Müller). (Plate XXIV. figs. 35–38, and Plate XXXVII. fig. 2.)

Cypris detecta, Müller, Entomostraca, p. 49, tab. iii. figs. 1–3.
Candona detecta, Baird, Brit. Entom. p. 161.

Valves, as seen laterally, oblong, reniform, nearly equal in height throughout; height equal to less than half the length. Dorsal margin evenly and gently arched; ventral gently incurved in the middle. The extremities are nearly equal in height, and evenly rounded. Outline, as seen from above, oval, tapering equally to the extremities, which are pointed; greatest width in the middle, equal to more than one-third of the length. End view nearly circular. Surface of the shell quite smooth and shining, pellucid, white; often with patches of white opacity. The biarticulate seta on the third joint of the lower antenna is slender and tapering, the basal joint being very short (as also in *C. albicans*, see Plate XXXVI. fig. 12 *m*). The first foot is robust, its claw long and much curved. Last joint of the second foot very small, bearing two moderately long and one short, the penultimate joint one seta. Postabdominal rami robust; claws strong and flexuous, the inner and shorter pectinated on both margins (Plate XXXVII. fig. 2 *i*). Male unknown.

Length $\frac{1}{40}$ in., height $\frac{1}{90}$ in.

Hab. C. detecta occurs pretty plentifully in the Glasgow and Paisley Canal, where it was found by Mr. D. Robertson. Dr. Baird gives as localities Beaumont Water and the neighbourhood of London.

Genus 6. Pontocypris, G. O. Sars.

Shell thin and fragile, higher in front than behind. The first joint of the upper antennæ gives origin to two short setæ, the four succeeding joints each to one, the sixth to four, and the seventh to four; those of the seventh joint being much the longest, the others gradually decreasing in length: the last joint of the lower antennæ is armed with four long and slender claws; and from the apex of the antepenultimate joint springs a brush of about five setæ, the longest of which do not much overreach the apices of the terminal claws; at the base of the joint is attached a pedicellated vesicle. Mandibles

* Transactions of the Zoological Society, vol. v. p. 368.

slender, divided into several curved teeth, and bearing near the apex a long ciliated seta; palp robust, the basal joint large and bearing a branchial appendage, the last joint very short and armed with several long spines. External segment of the first pair of jaws very large, the rest very short and setose, bearing a branchial appendage. Second pair of jaws destitute of a branchial appendage; palp large and subpediform, three-jointed, last joint, in the female, armed with two long, slightly curved claws. First pair of feet five-jointed, terminal claw very long. Second pair of feet flexuous, four-jointed, last joint short, armed at the extremity with several stout setæ, the margin of one of which is conspicuously pectinated. Postabdominal rami well developed, bearing at the apex two curved claws and a slender seta, inner margin bearing three long setæ; at the base, close to the termination of the intestinal canal, is a long seta arising from a dilated base. The ovaries are contained between the valves, forming a convolution or loop posteriorly. "The testes extend round the whole circumference of the valves." Mucus-gland apparently wanting.

This genus is chiefly distinguished from the freshwater Cypridæ by the excessive development of the palp of the second jaw (which is distinctly three-jointed and pediform), by the armature of the last pair of feet, and other minor peculiarities. In shell-structure it is very similar to *Cypris*, but in the conformation of the second jaw it shows an approach to the Cytheridæ. Sars observes that the animals are not very active in their habits, though they are quite well able to swim, and are not, like *Paracypris*, compelled to a mere crawling existence by the structure of their antennæ. They appear, however, to delight especially in a muddy bottom, and probably do not stir far away from it. I have found them especially abundant amongst the mud of oyster-beds, and in very quiet waters, where the bottom is covered with a great depth of soft ooze. The genus contains at least three British species.

1. Pontocypris mytiloides (Norman). (Plate XXV. figs. 26–30, Plate XXXVII. fig. 4, and Plate XXXVIII. fig. 1.)

Cythere mytiloides, Norman, Ann. & Mag. Nat. Hist. vol. ix. p. 50, pl. iii. figs. 1–3 (1862).
—— *avena*, Norman, Nat. Hist. Trans. Northumberland & Durham, vol. i. p. 17.
Cypris serrulata, G. O. Sars, Zoologisk Reise i Sommeren 1862, p. 58 (1863).
Pontocypris serrulata, Sars, Oversigt af Norges marine Ostracoder, p. 15.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Raised beaches and glacial clays, Scotland and Ireland.

Carapace, as seen from the side, elongated triangular, broad in front, tapering to a point behind; greatest height situated at the anterior third, equal to considerably less than half the length. Anterior margin broad and well rounded; posterior obtusely pointed. Dorsal margin very high and almost gibbous near the front, sloping steeply behind; ventral slightly sinuated in the middle. Outline, as seen from above, lanceolate, widest at the anterior third; greatest width equal to one-third of the length, extremities pointed. End view broadly oval. Surface of the shell granular or finely punctate, thickly set with short appressed hairs; colour purplish brown. The right valve is armed at the infero-posterior angle with 8–10 short marginal teeth. Hinge-margins simple,

except that each valve bears near the front a slightly projecting lamina, which articulates with that of the opposite side (fig. 30). Terminal claw of the first foot considerably longer than the united length of the three preceding joints; pectinated spine of the second foot much longer than the rest, and flexuous. Outer claw of the postabdominal ramus longer and stronger than the inner. Eye indistinct. The second pair of jaws, in the male, very strong, subchelate, unequal; the larger terminal claw of the right side very broad and triangular; that of the left side elongated, slender, and much curved. The terminal joint of each jaw bears also a smaller, obtuse and moveable claw, in opposition to the larger one; this smaller claw is, on the left side, armed with two unequal setæ, the longer springing from the base at the inner side, the shorter from near the middle of the outer margin. The copulative organs are of irregular shape, having two slender hooked processes, and two more-robust segments, which are also hooked at the extremity.

Length $\frac{1}{35}$ in., height $\frac{1}{80}$ in.

Hab. Chiefly on a soft muddy bottom in depths of 2–60 fathoms. Shetland, Hebrides (*Mr. Jeffreys**); Skye, Lamlash, Tobermory (*Rev. A. M. Norman*); Cumbrae, Peterhead (*Mr. D. Robertson*); Aberdeenshire coast (*Mr. Dawson*); Plymouth, 5 and 60 fath. (*Mr. C. Spence Bate*); Stranraer, in oyster-ooze; Galway Bay, Birterbuy Bay, Channel Islands, and Northumberland coast (*G. S. B.*).

This is, as the foregoing list of localities sufficiently shows, a very widely distributed species, having been found at all extremities of the British seas, and also in Norway, where, however, it seems to be rare. The peculiar colour, texture, and shape of the shell at once distinguish it from all other species. *P. acupunctata* is, indeed, very similar in colour, but differs decidedly in shape, and is, besides, an excessively rare species.

The specific name *mytiloides*, under which this species was originally described by Mr. Norman, was afterwards withdrawn, on account of the name having been preoccupied by Reuss. But as the animal can no longer be referred to the genus *Cythere*, I have thought it right to restore the original name on the ground of priority.

2. Pontocypris acupunctata, Brady. (Plate XXV. figs. 53–56.)

Pontocypris acupunctata, Brady, Brit. Assoc. Report, 1866, p. 209.

Lateral view oblong, subreniform, or bean-shaped, highest in the middle; height equal to half the length. Anterior extremity rounded, posterior obtusely pointed. Dorsal margin arched, sloping more steeply behind than in front; ventral deeply sinuated at the anterior third. Outline, as seen from above, compressed, oval, widest about the middle; width equal to one-third of the length; pointed in front, rounded behind. End view oval. The surface of the shell, under a low power of the microscope, appears to be very finely punctate; but a higher power shows that each mark is really an exceedingly short hair. Colour purplish brown. Animal unknown.

Length $\frac{1}{48}$ in., height $\frac{1}{100}$ in.

Hab. The Minch, 45–60 fath. (*Mr. Jeffreys*); in shell-sand, Roundstone (*Dr. Alcock*).

* The authority of several collectors might often be given for the same locality; but, for the sake of brevity, I have, in most cases, inserted one name only.

Of this pretty little species I have seen only three specimens—two found amongst shell-sand from Connemara by Dr. Alcock, the other dredged off the Hebrides by Mr. Jeffreys. The Irish specimens were completely bleached, but that from the Minch was well coloured. My drawings were taken from the former, and exhibit the lucid spots very distinctly. These are not visible in the fresh specimen. From the colour and general characters of the shell, I have no hesitation in assigning it a place under the genus *Pontocypris*. It seems to be quite distinct from any hitherto described species.

3. PONTOCYPRIS TRIGONELLA, G. O. Sars. (Plate XXV. figs. 31–34, and Plate XXXVIII. fig. 3.)

Pontocypris trigonella, Sars, Oversigt af Norges marine Ostracoder, p. 16.

British type. DISTRIBUTION: *Recent*—Norway, Great Britain, Ireland, Mediterranean, Cape Verde. *Fossil*—Raised beaches and glacial clays, Scotland and Ireland.

Shell less compressed than in either of the foregoing species; seen from the side, subtriangular, rather higher in front than behind; greatest height nearly in the middle, and equal to half the length. Anterior extremity rounded, posterior obtusely pointed. Dorsal margin strongly arched, ventral gently sinuated in front, and sweeping upwards with a slight convexity behind. Seen from above, elongate oval, widest a little in front of the middle; width equal to more than one-third of the length; acutely pointed in front, obtusely behind. End view broadly oval. Shell very slightly pilose, dull white in colour, clouded with opaque patches. The terminal claw of the first pair of feet rather more than equalling in length the three preceding joints. Second joint of the last pair of feet more than equal in length to the following two joints; pectinated spine short. Post-abdominal rami obliquely truncate at the apex; terminal claws nearly equal; inner marginal setæ slender, and longer than the claws. Second jaws of the male strong and subchelate, alike on both sides, terminal claw of moderate length. Copulative organs subhamate. "Eye large and distinct, composed of three lenses, two lateral and one anterior."

Length $\frac{1}{38}$ in., height $\frac{1}{76}$ in.

Hab. In 3–30 fathoms. Plymouth (*Mr. Spence Bate*), Frith of Clyde (*Mr. D. Robertson*); in shell-sand from Guernsey and Birterbuy Bay, Galway Bay, and plentifully in oyster-ooze from Stranraer (*G. S. B.*); in tidal pools, Arran and Herm (*Rev. A. M. Norman*), Estuary of Thames (*Mr. E. C. Davison*).

A pretty species, and easily distinguished from others of the genus by its shape and colour.

4. PONTOCYPRIS (?) ANGUSTA, n. sp. (Plate XXXIV. figs. 43, 44.)

Carapace, as seen from the side, oblong, semiovate, highest in the middle; greatest height much less than half the length. Anterior extremity rounded, posterior narrowed and obliquely rounded; superior margin arcuate, highest in the middle, sloping steeply behind; inferior sinuated in front of the middle, straight behind.

from above, ovate, widest in the middle; greatest width equal to more than one-third of the length. Shell smooth, pellucid, yellowish. Animal unknown.

Length $\frac{1}{55}$ in.

Hab. Birterbuy Bay, 10 fathoms (*G. S. B.*).

Several examples of this species occurred in my dredgings; but, owing to their having been dried slowly with the mud in which they were taken, all trace of the animal structure has disappeared; and I can therefore only conjecture that they possibly belong to the genus *Pontocypris**.

Genus 7. Bairdia, M'Coy.

Valves unequal in size, the left being considerably the larger and overlapping the right both on the dorsal and ventral surfaces. Surface of the shell smooth or nearly so. Carapace, as seen from the side, mostly obliquely subquadrate. Animal imperfectly known. Postabdominal rami well developed, with long and slender terminal claws; marginal setæ long and crowded together near the apex.

Though examples of this genus are not particularly uncommon, I have only in one instance succeeded in finding a carapace containing the animal; and even this was so imperfect as to prevent my obtaining accurate information as to its structure. Such of the limbs as I was able to draw are figured in Pl. XXXVIII.; but I cannot name them with absolute certainty. The size of the various species would make it a very easy matter to determine their structural characters if they could be procured in a living state. The specimens in my collection have all been picked from masses of dried mud or sand; and in such cases it is seldom that the soft parts remain intact. The formation of the abdominal rami, however, shows distinctly that this genus must be classed amongst the Cypridæ; and, from the characters of the shell, I conclude that it is, in all probability, closely related to the following genus, *Macrocypris*.

The British species are four in number, and are exclusively inhabitants of moderately deep water†, ranging, in the British seas, from 10 to 60 fathoms.

The numerous fossil forms described under the generic name *Bairdia* seem to be referable to many distinct genera.

1. Bairdia inflata (Norman). (Plate XXVII. figs. 9–17, & Plate XXXVIII. fig. 5.)

Cythere inflata, Norman, Ann. & Mag. Nat. Hist. vol. ix. p. 49, pl. iii. figs. 6–8.

—— *subdeltoidea*, Brit. Mus. Cat. Brit. Crust. p. 108 (*fide* Norman).

Bairdia subdeltoidea, A. White, Pop. Hist. Brit. Crust. p. 293; narrow var., Jones, Entom. Cretaceous Formation of England, p. 23, and Tert. Entom. p. 52.

Atlantic type. Distribution: *Recent*—Great Britain, Ireland. *Fossil*—Raised beaches, Scotland.

Shell tumid; as seen from the side subrhomboidal in outline, highest near the middle;

* Since this was written the specimens on which the genus *Aglaia* is founded have come into my hands; and it is more than probable that the present species will prove to be referable to the same genus.

† I use the term "deep water" solely with reference to the depths attainable round the British Islands, which are, indeed, quite shallow in comparison with those met with in the open ocean, or even on such coasts as that of Norway, where 300 fathoms is frequently quoted.

greatest height equal to half the length. Anterior margin flattened, waved, running obliquely upwards and forwards, and bordered, in many cases, by a flattened spinous lamina (figs. 14–17). Dorsal margin forming a flattened arch, truncate in the middle; ventral straight or slightly waved, bulging into a protuberant angle at its junction with the anterior margin. Posterior margin narrow, rounded, or almost angular, and frequently encircled by a narrow squamous lamina, which is irregularly dentated or spinous (figs. 13–17). Outline as seen from above tumid, oval; greatest width in the middle, equal to rather less than half the length; extremities obtusely pointed; line of junction of the valves waved; on the ventral margin the left valve much overlaps the right. End view subtriangular, broad and rounded below; width and height nearly equal. Surface smooth and polished, or finely punctate; pearl-white or cream-coloured. The anterior extremity of the carapace bears sometimes, in old and well-grown specimens, a number of short pointed tubercles, and is occasionally, as also the hinder extremity, beset with coarse brown hairs (fig. 13). Lucid spots six to nine, arranged in a rosette. Postabdominal rami terminating in two slender curved claws; the internal very long and finely tapered, considerably exceeding in length the ramus itself; the external more slender and about half as long: on the internal border of the ramus, and very near its apex, are five slender setæ; the upper two very short, the rest about equal in length to the shorter claw.

Length $\frac{1}{25}$ in., height $\frac{1}{50}$ in.

Hab. Lamlash Bay (*Rev. A. M. Norman*); Channel Islands, 15–30 fath., Loch Alsh and the Minch (*Mr. Jeffreys's dredgings*); Shetland (*Mr. D. Robertson*), off Hoy Head (*Mr. D. O. Drewett*); Devonshire coast, 60 fath. (*Mr. Spence Bate's dredgings*); in shell-sand from Arran and Galway Bay (*Prof. Rowney*), and from Roundstone (*Dr. Alcock*); dredged in Poolvash Bay, Isle of Man, 12–15 fath., and in Birterbuy Bay, 10–15 fath. (*G. S. B.*).

This very interesting form was first described as a distinct species by the Rev. A. M. Norman, under the name of *Cythere inflata*. Mr. Norman's specimens were taken from shell-sand dredged in Lamlash Bay, from which locality Prof. T. Rupert Jones had also previously obtained the species, considering it a variety of *Bairdia subdeltoidea*. Its characters are, however, very distinct and constant; and although some forms of *B. subdeltoidea* approach it very closely, I agree with Mr. Norman in the opinion that it should be regarded as a distinct species. The typical form of *B. subdeltoidea*, has not, so far as I know, been met with, in a recent state, in the British seas. A few specimens of it occur in Mr. Jeffreys's Channel-Island dredgings, but they have the appearance of fossil shells; and as several Foraminifera dredged in the same place are evidently derived from some submarine fossiliferous bed, the most reasonable inference is that the *Bairdiæ* were likewise derived from the same source. One very fine specimen of *B. inflata* occurred in the same dredgings, and is abundantly distinct from the fossil forms with which it was associated.

Bairdia inflata is tolerably abundant in Galway Bay and the neighbouring seas, but appears to decrease rapidly in numbers to the east. On the eastern shores of Britain I have no record of its occurrence.

2. Bairdia acanthigera, n. sp. (Plate XXVII. figs. 18–21.)

Atlantic type. Distribution: *Recent*—England.

Valves tumid; seen from the side subquadrilateral, nearly equal in height throughout; greatest height in the middle, equal to about half the length. Anterior margin broad, flattened, or obliquely rounded, armed with six to eight short blunt spines or tubercles, which project straight forward. Posterior extremity obliquely rounded towards the dorsum, bearing at the ventral angle about four spines, similar to those on the front of the shell. The dorsal margin forms a flattened arch, and is highest in the middle, sloping rather steeply behind. Ventral margin slightly concave in front of the middle, swelling into a rounded, flattened protuberance in front. Dorsal aspect elliptical, with flattened sides and suddenly tapering extremities; breadth equal to about half the length; line of junction of the valves waved. The left valve is the larger, and, in the centre of the ventral surface, considerably overlaps the right. End view somewhat triangular, flexuous, angles rounded. The surface of the shell is closely punctate; colour dull white. Lucid spots seven or eight, forming a rosette. Animal unknown.

Length $\frac{1}{33}$ in., height $\frac{1}{70}$ in.

Hab. In deep water. Channel Islands (*Mr. Jeffreys's dredgings*); Devonshire coast, 60 fathoms (*Mr. Spence Bate's dredgings*); Plymouth, from trawlers (*Mr. Barlee*).

3. Bairdia obtusata, G. O. Sars. (Plate XXXIV. figs. 22–25.)

Bairdia obtusata, Sars, Oversigt af Norges marine Ostracoder, p. 24.

Scandinavian type. Distribution: *Recent*—Norway, Scotland.

Carapace moderately compressed; lateral view subrhomboidal, highest near the middle; greatest height equal to half the length. Anterior extremity obliquely rounded, almost truncate; posterior obliquely rounded, almost angular below, well rounded above. Dorsal margin evenly arched; ventral gently sinuated in front, and somewhat convex behind. Seen from above, the outline is elongate oval, the extremities equally and obtusely pointed; greatest width in the middle, equal to more than one-third of the length. The left valve overlaps distinctly along the whole length of the dorsum, and forms a distinct overlapping curvature in the middle of the ventral surface. Hinge-line slightly flexuous. End view broadly oval. Surface smooth, white or fawn-coloured. Animal unknown.

Length $\frac{1}{25}$ in., height $\frac{1}{50}$ in.

Hab. The Minch, 45–60 fathoms (*Mr. Jeffreys*).

I have met with only two specimens of this very distinct species, both of them dredged near the Hebrides by J. G. Jeffreys, Esq.

4. Bairdia complanata, Brady. (Plate XXXIV. figs. 1–4.)

Bairdia complanata, Brady, Brit. Assoc. Report, 1866, p. 210.

Scandinavian type? Distribution: *Recent*—Scotland.

Carapace much compressed; seen from the side subreniform, highest in the middle; greatest height equal to about half the length; anterior extremity evenly rounded, posterior narrowed and somewhat obliquely rounded. Dorsal margin boldly arched,

highest in the middle, and sloping steeply behind; ventral gently sinuated in front, and slightly convex behind. Seen from above, the outline is compressed, oval; extremities equally and rather obtusely pointed; greatest width in the middle, equal to about one-third of the length. Hinge-line slightly sinuous. The left valve overlaps considerably on the dorsum and in the middle of the ventral surface. Shell smooth, colour pale ochreous or white, opaque. Animal unknown.

Length $\frac{1}{20}$ in., height $\frac{1}{40}$ in.

Hab. The Minch, 45–60 fathoms (*Mr. Jeffreys*).

This very fine and distinct species occurred in the same dredgings with *B. obtusata*, and though more abundant than the latter species, must still be considered rare.

Genus 8. Macrocypris, Brady*.

Carapace much elongated, attenuated at the extremities. Valves unequal, the right larger than the left, and overlapping dorsally; hinge-line flexuous. Surface smooth, polished, and destitute of hairs. Antennæ short and robust, the superior seven-jointed, joints tapering towards the apex, bearing short setæ; the inferior composed of five distinct joints, last two joints very short; armed with much-elongated claws; second joint bearing on its inner side near the base a bundle of short biarticulate setæ. Mandibles large, dilated at the inferior extremity, and divided into six or seven strong teeth; palp elongated, four-jointed, and having a distinct branchial appendage. First pair of jaws provided with an unusually small subovate branchial plate; external lobe or palp narrow, not larger than the rest. Second pair of jaws destitute of a branchial appendage; palp, in the female, large and subpediform, composed of four distinct joints, the last armed with three claws or spines; in the male very robust and subcheliform. First pair of feet much elongated, five-jointed, last joint armed with one or two long forward-curved claws; the second pair very different, and covered entirely by the shell, five-jointed, last joint armed with a very long recurved claw. Postabdominal rami rudimentary, forming two small and simple appendages attached to the posterior part of the abdomen. No eye. Male smaller than the female; copulative organs large and provided at the anterior extremity with a much-elongated mucus-gland.

The species constituting this genus are included by Sars under *Bairdia*; that author, however, had had no opportunity of examining the animals belonging to the group typified by *B. subdeltoidea*, to which the name *Bairdia* was originally given by M'Coy. I have myself so far succeeded in the investigation of the animal structure as to find ample generic characters in the formation of the postabdomen, though the other portions of its anatomy remain to be worked out. But, in addition to peculiarities of animal structure, the carapace presents well-marked differences, in its attenuated form and in the respective size of the valves, the *right* being here much the larger.

Sars observes that this marine genus seems to be analogous to the freshwater genus *Candona*, just as *Pontocypris* appears to be the marine equivalent of *Cypris*. The only British species is

* Intellectural Observer, vol. xii. p. 119.

Macrocypris minna (Baird). (Plate XXVII. figs. 5–8, and Plate XXXVIII. fig. 4.)

Bairdia minna, Sars, Oversigt af Norges mar. Ostrac. p. 21.
Cythere minna, Baird, Brit. Entom. p. 171, tab. xx. figs. 4, 4*a–d*.
Scandinavian type. Distribution: *Recent*—Norway, Shetland.

Carapace rather tumid; seen from the side elongated, subtriangular, rounded in front, acutely pointed behind; greatest height near the middle, equal to two-fifths of the length. Dorsal margin much arched, highest in the middle, thence sloping with a gentle curve forwards, but steeply behind, where it joins the ventral margin at an acute angle. The ventral margin is slightly sinuated in front, and runs backwards in a right line to the posterior extremity. Outline, as seen from above, ovate lanceolate, sharply pointed behind, more obtusely in front; greatest breadth in front of the middle, equal to more than one-third of the length; line of junction of the valves waved. End view subcircular; height rather greater than the breadth. Surface perfectly smooth and polished, white, the animal itself deep brown. "Antennæ short and robust, fourth joint of the upper about equal in length to the following joint; sixth joint of the lower antennæ shorter than the fifth, terminal claws very long and subequal. Marginal spines of the palp of the second pair of jaws minutely dentate. Second joint of the first pair of feet much shorter than the united lengths of the two following; last joint moderately long, armed with a short seta and two unequal claws, one twice as long as the other. Margins of the terminal claw of the last pair of feet shortly and densely pilose. Postabdominal rami forming two appendages springing from a common base, bearing on the middle of the posterior margin a small brush of hairs, and at the apex a long seta. Copulative organs of the male laminar, obtusely subtriangular."

Length $\frac{1}{10}$ in., height $\frac{1}{24}$ in.

Hab. "Dredged in from 80 to 90 fathoms of sand, twenty miles east of the Noss in the Shetland Isles, *R. M'Andrew, Esq.*" (*Dr. Baird*).

The only British specimen of this species which I have seen is in Mr. Norman's collection, and was dredged in Shetland. *M. minna* occurs also on the Norwegian coast; and I am indebted to Hr. G. O. Sars for Norwegian specimens, from which I have been able to verify most of the details of his description of the animal above quoted. In the British seas the species is excessively rare, but on some parts of the Norwegian coast, according to Sars, is tolerably common, ranging from 20 to 300 fathoms: it is quite destitute of swimming-power.

Family 2. Cytheridæ.

CYTHERIDÆ. — Mouth provided with a lip and labrum. Mandibles toothed at the lower extremity.

Lower antennæ 4-jointed. Upper antennæ — 5-jointed; last three joints:

- elongated, their united lengths more than that of the preceding joint; more or less strongly spiniferous. Feet in the male and female:
  - destitute of spines; bearing only a few short slender setæ . . . . . *Limnicythere.*
  - alike. Internal lobe of the first pair of maxillæ:
    - well developed . *Cythere.*
    - rudimentary . . *Eucythere.*
  - dissimilar; right foot of first pair in the male prehensile, right of the second pair very weak and rudimentary . . . . . *Cytheridea.*
- short and stout, their united length shorter than that of the preceding joint, bearing long curved spines. First two pairs of feet only 3-jointed. Right foot of last pair in the male prehensile. Eyes wanting . . . . . *Ilyobates.*

Lower antennæ 4-jointed. Upper antennæ — 6-jointed; beset with simple setæ; last four joints:

- short and gradually decreasing in length . . . . . *Xestoleberis.*
- mostly much elongated and slender, unequal . . . . . *Loxoconcha.*

Lower antennæ 4-jointed. Upper antennæ — 7-jointed; first two joints very large and stout, last five slender and bearing moderately long setæ . . . . . *Bythocythere.*

Lower antennæ 5-jointed. Upper antennæ

- 5-jointed; beset with short scattered hairs. Postabdominal lobes broad and short, bearing three setæ. No eyes . . . . . *Cytheropteron.*
- 6-jointed; last four joints:
  - much narrower than the preceding, and bearing scattered short hairs, which are in part spiniform. Postabdominal lobes rudimentary, destitute of hairs. Two separate eyes . . . . . *Cytherura.*
  - not narrower than the preceding, and beset towards the apex with numerous long setæ. Postabdominal lobes larger than ordinary, bipartite, and bearing five setæ. One eye . . . . . *Sclerochilus.*
- 7-jointed, bearing numerous very long setæ, last joint very long and slender; two basal joints large and stout. Postabdominal lobes subconical, directed downwards, and bearing three hairs. Eyes wanting . . . . . *Pseudocythere.*

. . . . . (*Cytheridæis*).

Mouth simple, tubiform; its orifice surrounded by a circular disk situated at the apex of a large subconical protuberance. Organs of mastication poorly developed and weak. Mandibles styliform; palp very narrow, destitute of a branchial appendage. First pair of jaws composed of narrow and partly imperfect lobes. Upper antennæ 6-jointed, very slender; inferior 5-jointed and shorter; flagellum large and robust. Eye single . . . . . *Paradoxostoma.*

Shell mostly hard and compact, calcareous; surface generally more or less rough and uneven, occasionally quite smooth. Hinge-margins mostly toothed. Antennæ not adapted for swimming, the upper composed of five to seven joints and armed with various setæ or spines; the inferior 4–5-jointed, the last joint the smallest, and armed with one to three curved claws, second joint destitute of the brush of setæ which mostly occurs in the Cypridæ; first joint giving origin, at its apex, to a long biarticulate tubular seta, which extends downwards in front of the antenna about as far as the last joint, and above is connected by an efferent tube with a gland situated in the body of the animal. Mandible very similar to that of the Cypridæ. One pair of jaws, composed of four segments, with a branchial plate. Three pairs of feet, directed forwards, very much alike in shape, but increasing in length from before backwards; all of them adapted for creeping, and terminating in a single strong curved claw. The first foot corresponds with the palp of the second maxilla in the Cypridæ, the cutting segments being represented by two small setiferous appendages, arising from a common base. Postabdomen rudimentary and

almost obsolete, forming two small lobes or setæ. Eyes mostly separate, sometimes confluent, more rarely altogether wanting. Ovaries and testes not extending between the valves. Male copulative organs very large and complex in structure. Mucus-gland wanting.

This family comprises by far the larger portion of the marine Ostracoda, but is very sparingly represented in fresh water, of which, amongst the British species, only two or three are inhabitants. Almost all the numerous fossil species are likewise referable to the Cytheridæ. The most important differences between this family and the preceding are found in the structure of the lower antennæ and the mandibular palp—also in the number of feet, which in the Cypridæ are *two*, in the Cytheridæ *three* pairs, the appendage forming the second pair of jaws in the former family assuming the shape of an ambulatory foot in the latter. They are quite destitute of swimming-power. The lower antenna is armed with a curved bi- or triarticulate seta, which reaches downwards in front of the limb from the apex of the first joint, and mostly extends nearly to the apex of the terminal claws: at its base this is connected by a duct with a gland or vesicle situate in the anterior part of the body. It seems impossible to imagine any other use for this organ than that of an urticating or poison-bearing weapon. In some few species the lower antenna bears also near its apex a minute pyriform vesicle somewhat similar to that of *Pontocypris* &c., but considerably smaller. The limbs, especially the antennæ, are mostly strengthened on their anterior and posterior surfaces by bucklers or plates of strong chitinous tissue, probably to afford a firmer attachment to their powerful muscles.

Genus 1. Cythere, Müller.

Valves unequal, mostly very thick and strong. Surface marked in the simpler forms with slightly elevated papillæ or tubercles, and fine punctations; in others with deep pits or fossæ, and with very prominent elevations, which take the shape of sharp ridges, spines, or tubercles. Lateral view subreniform or subquadrangular, mostly highest in front. The hinge-joint consists of two strong teeth on the right valve, which articulate with corresponding depressions of the left valve; the two teeth are often connected by a strongly developed bar, which fits into a furrow of the opposite valve-margin; the anterior tooth is much the strongest. The margin of the left valve mostly has a single small tooth behind the anterior hinge-fossa, and sometimes one also at the posterior extremity of the hinge-line; the anterior fossa occasionally forms a complete circular perforation of the marginal plate, and the central portion of the hinge-line is sometimes minutely crenulated. Antennæ robust; superior five- to six-jointed, armed on the anterior margin with three long curved spines, mostly one on the third and two on the fourth joint; lower four-jointed, the last joint short and stout. Mandibular palp three- to four-jointed, bearing, in place of a branchial appendage, a tuft of two to five setæ. Eyes one or two.

I have thought it necessary to include in this genus the forms assigned by Sars to the two genera *Cythere* and *Cythereis*. In the first place, the characters taken by that author as the ground of generic distinction seem to me inadequate; secondly, four of our British

species, *C. albomaculata*, *convexa*, *rubida*, and *pulchella*, present intermediate characters, and could not be included under either of the genera as defined by Sars. The chief distinctive characters taken by him as the ground of separation are the length of the urticating seta of the lower antenna (which, in the females of "*Cythereis*," is exceedingly short), the structure of the mandibular palp, and the abdominal rami. These characters may be tabulated as follows:—

	Cythere, Sars.	*Cythereis*, Sars.
Urticating seta of lower antenna	of equal length in male and female.	very short in the female.
Mandibular palp . . .	composed of three joints, and simply setose; two branchial filaments.	composed of four joints, and bearing three strong, curved pectinate setæ; five branchial filaments.
Postabdominal rami . . .	forming two obtuse lobes.	bearing two or more stout ciliated setæ.

If the characters here ascribed to *Cythereis* could have been shown to be uniformly coincident with the quadrangular and rugose forms of carapace for which the genus *Cythereis* was originally proposed, or even if they could have been applied with precision to any group, without respect to shell-structure, they might perhaps, though dubiously, have been allowed to form the basis of a distinct genus; but seeing that we have forms distinctly partaking of the characters of both genera, there seems no reasonable course but that of uniting the two under one name.

C. albomaculata, with the shell-characters and urticating setæ of *Cythere*, has the mandibular palp and abdominal rami of *Cythereis*. *C. convexa* is perhaps intermediate in form of carapace, but much more near to *Cythere* than to *Cythereis*, while the urticating seta and mandibular palp agree with those of *Cythereis*. Both species possess further characters (in the lower antennæ) which are, so far as I know, peculiar to themselves. The abnormal characters of *C. rubida* and *pulchella* will be pointed out in the descriptions of those species.

a. *Valves elongate or reniform, punctate, not prominently rugose or spinous.*

* *Mandibular palp three-jointed, simply setose; urticating seta long, equal in the male and female.*

1. Cythere lutea, Müller. (Plate XXVIII. figs. 47–56, and Plate XXXIX. fig. 2.)

Cythere lutea, Müller, Entomostraca, p. 65, tab. vii. figs. 3, 4; Sars, Oversigt af Norges mar. Ostrac. p. 28; Zenker, Anat.-syst. Stud. über die Krebsthiere, p. 83, Taf. v. C.

—— *reniformis*, Baird, Brit. Entom. p. 169, tab. xx. figs. 5, 5 *a–f*.

—— *setosa*, Brady, Trans. Zool. Soc. vol. v. p. 371, pl. 58. figs. 12 *a–c*, 13 *a–d*, 15 *a* (not 15 *b–e*).

Scandinavian type. Distribution: *Recent*—Baffin's Bay, North Sea, Baltic, Great Britain, Ireland, Mediterranean. *Fossil*—Raised beaches and glacial clays, Scotland, Ireland, and Norway.

Carapace reniform, compressed. In the *female* the extremities are obliquely rounded and nearly equal; the greatest height in the middle, equal to considerably more than half the length. Dorsal margin gently and evenly arched, ventral deeply sinuate, owing to the partial disappearance of a broad flattened flange which borders the extremities and most of the inferior margin. Seen from above, the outline is compressed, oblong

oval; greatest breadth behind the middle, equal to less than half the length; the hinge-margins thickened and depressed centrally, so as to form a longitudinal sulcus, but uniting at the extremities, thus forming a broad keel. End view oval, keeled below, sulcate above. The central portion of the valves is covered with a calcareous crust, and bears numerous small puncta and a few scattered hairs. Colour yellowish or drab in specimens from beyond low-water mark, brick-red in the littoral variety. The hinge-joint consists (fig. 56), in the left valve, of a long central knurled bar, at each end of which is a fossa for the reception of a corresponding knurled protuberance of the right valve. The right valve differs from the left in being taller and more angularly truncate at the extremities. The shell of the *male* is much more elongate and angular, more deeply sinuated below, and often more rugose on the surface. Colour of the limbs deep brownish yellow. Last joint of the upper antennæ very short: terminal spine very slender, almost setose. Feet short and robust; terminal claws strong and curved, that of the last foot indistinctly setose or pectinate on the inner margin. Abdominal lobes short and thick, surrounded with short setæ. Copulative organs of the male large, the basal portion quadrangular, the apical portion produced into two tapering prolongations.

When living in the Laminarian zone, and in deeper water, this species presents somewhat different characters: the shell is considerably larger, the dorsal margin generally more flattened, the surface marked with distant deep punctations, between which are scattered numerous smaller puncta; the marginal portions tend also to become elevated into irregularly radiating ribs. This latter character is more conspicuous in the male (fig. 47), which is also more distinctly punctate and more angular in outline, the ventral margin especially forming a remarkable angular projection posteriorly. This form is, indeed, so distinct that until recently I supposed it to belong to a distinct species, *C. setosa*, Baird; but having now had the opportunity of examining a large series of dredged specimens, as well as a still greater number of carapaces from the glacial clays of Scotland, I cannot avoid the conclusion that it represents merely a deep-water form of the present species, which had previously been known to me only from littoral specimens.

Length (littoral var.) $\frac{1}{40}$ in., height $\frac{1}{66}$ in.; (deep water var.) length $\frac{1}{34}$ in., height $\frac{1}{55}$ in.

Hab. Abundant in tide-pools on the coasts of Northumberland and Durham, and in oyster-ooze from Stranraer (*G. S. B.*); "coast of Berkwickshire, at Cockburnspath, Berwick, &c.; North Foreland" (*Dr. Baird*); dredged at Oban and Cumbrae, Macduff and Peterhead (*Mr. D. Robertson*); the Minch, 45–60 fathoms (*Mr. J. G. Jeffreys*); Guernsey, Shetland, and amongst roots of Laminaria at Tobermory (*Rev. A. M. Norman*); Long Hope, Orkney (*Mr. C. W. Peach*).

This species is found by Sars abundantly on the Norwegian coast, by Zenker in the Cattegat, and is common also on the northern shores of Britain and in the Arctic seas; I have seen but few specimens from the southern and western coasts of England and Ireland. It occurs abundantly in a fossil state in the glacial clays of Scotland.

2. CYTHERE VIRIDIS, Müller. (Plate XXVIII. figs. 40, 41, & 57–59; and Plate XXXVIII. fig. 8.)

Cythere viridis, Müller, Entomostraca, p. 64, tab. vii. figs. 1, 2; Sars, Oversigt af Norges marine Ostrac. p. 30.

British type. DISTRIBUTION: *Recent*—Norway, Great Britain, and Ireland. *Fossil*—Raised beaches and glacial clays, Norway, Scotland, and Ireland.

Very similar to the foregoing, but much smaller. Shell of the *female*, as seen from the side, subreniform, slightly higher in front than behind, greatest height equal to two-thirds of the length. Anterior extremity obliquely rounded; posterior rather narrower, rounded. Dorsal margin nearly straight, sloping gently backwards from the front, where it is slightly angular; inferior distinctly sinuated in front of the middle. Seen from above, the outline is ovate, more sharply pointed in front than behind, about twice as long as broad. Surface marked with numerous fine puncta, which are interspersed with small tubercles. Colour olive or yellowish-brown. The shell of the *male* is much narrower and more elongated. The animal itself is almost colourless. Last joint of the upper antenna much elongated, almost equal in length to the two preceding. Feet very short. "Copulative organs of the male subtriangular, the apical portion obtusely rounded."

Length $\frac{1}{55}$ in., height $\frac{1}{90}$ in.

Hab. The Minch, 45–60 fath. (*Mr. J. G. Jeffreys*); Shetland, Peterhead, Isle of Man, and Cumbrae (*Mr. D. Robertson*); Galway Bay, Birterbuy Bay, Baltimore, Roundstone Bay, Stranraer, and in tide-pools near Sunderland (*G. S. B.*); in tide-pools, Arran and Channel Islands (*Rev. A. M. Norman*); Girdler sand, Thames, and Scarpa Flow, Orkney (*Mr. E. C. Davison*).

C. viridis might very easily be passed over as the young of *C. lutea*; but, besides that the shell-characters are very constant, those of the animal itself are quite sufficiently distinct. It is not by any means so common a species on the northern British shores; but it may often have escaped notice on account of its small size.

3. CYTHERE PELLUCIDA, Baird. (Plate XXVIII. figs. 22–26, 28.)

Cythere pellucida, Baird, Brit. Entom. p. 173, t. xxi. fig. 7; Sars, Oversigt af Norges marine Ostrac. p. 31.

British type. DISTRIBUTION: *Recent*—Norway, Great Britain and Ireland, Mediterranean. *Fossil*—Raised beaches and glacial clays, Norway, England, Scotland, and Ireland.

Valves of the *female* compressed, oblong; as seen from the side, subquadrangular, equal in height throughout, rounded in front, angulated behind on the dorsal margin, height equal to less than half the length. Anterior margin obliquely rounded, posterior subtruncated rounded off below, almost rectangular above. Dorsal margin very slightly arched, ventral distinctly sinuated in front of the middle. Outline, as seen from above, compressed ovate, greatest width near the posterior extremity and equal to one-third of the length. End view broadly ovate. The *male* is much more elongated than the female, and has the supero-posteal angle more produced. The centre of each valve is marked with a distinct transverse sulcus, and sometimes also with two shallower ones near the extremities. The substance of the shell is rather thin and horny; its surface covered with thickly set, circular or often oblong puncta, which vary much in size in

different specimens. Specimens from deep water are often much incrusted and porcellaneous, the surface-sculpture almost obliterated (see fig. 28). Colour brown, or dull white. Colour of the animal deep brown. Antennæ short and stout, the fourth joint very short, the last much elongated and slender, nearly twice the length of the preceding. Second joint of the mandibular palp broad at the apex, the last joint armed with three short spines. Last pair of feet fully twice as long as the first, the second joint very long, the last joint bearing at the apex four short and sharp spines. Copulative organs of the male dilated at the extremity, and produced into long tapering processes, one of which is much more slender than the other. Abdominal lobes feebly developed and bearing a short seta.

Length $\frac{1}{38}$ in., height $\frac{1}{99}$ in.

Hab. From littoral situations up to 60 fathoms. Shetland, Stornoway, Skye, Lamlash Bay, Tenby, Swansea, Plymouth, Youghall; in tide-pools, Arran and Channel Islands (*Rev. A. M. Norman*); Orkney (*Mr. C. W. Peach*); Aberdeenshire coast (*Mr. Dawson*); Oban, Cumbrae, Campbeltown, Macduff, Peterhead, and Ormeshead, dredged (*Mr. D. Robertson*); dredged amongst the Hebrides and Channel Islands (*Mr. J. G. Jeffreys*); Devonshire coast, 60 fathoms (*Mr. Spence Bate*); Norfolk coast (*Mr. D. O. Drewett*); in shell-sand from the Mumbles (South Wales), the Ribble, Preston Pans, Stranraer, Margate, Baltimore, Donegal Bay, and Roundstone; Northumberland and Durham coasts, 25–46 fathoms, and Birterbuy Bay, 15 fathoms (*G. S. B.*).

Cythere pellucida, though exceedingly variable in habitat, surface-sculpture, and in the proportions of the carapace, is easily distinguished by the peculiar dorsal angulation of the posterior border and by its one or more deep transverse sulci. Old specimens, however, are not always recognizable with facility, the surface-markings becoming very vague, and the contours of the shell less characteristic. The following species approaches very closely to *C. pellucida*, but is never met with except in brackish or subbrackish situations; and, in addition to this peculiarity of habitat, its shell-structure affords characters which, on close examination, will not fail to distinguish it.

4. Cythere castanea, G. O. Sars. (Plate XXVIII. fig. 27, and Plate XXXVIII. fig. 6.)

Cythere castanea, G. O. Sars, Oversigt af Norges marine Ostracoder, p. 32.

British type. Distribution: *Recent*—Great Britain, Norway. *Fossil*—Glacial, Scotland.

Carapace of the *female*, as seen from the side, subreniform, rather higher in front than behind, greatest height in front of the middle, equal to half the length. Anterior extremity well rounded, posterior rounded off below, angular above at its junction with the dorsal margin; superior margin slightly arcuate and sloping backwards from the anterior third, where it is highest; inferior distinctly sinuated in the middle, curving upwards behind. Seen from above, the outline is ovate, widest in the middle, in front of which it is distinctly constricted, pointed in front, rounded behind, greatest width considerably less than the height. The shell of the *male*, seen laterally, is much more tapered behind; the supero-posteal angle much pronounced, the infero-posteal thoroughly rounded off; dorsal margin quite straight and rather steeply sloping backwards. Surface of the valves thickly covered with small rounded depressed puncta, and marked with

two curved transverse furrows; colour reddish brown. Animal precisely like that of *C. pellucida*.

Length $\frac{1}{42}$ in.

Hab. Chiefly in the brackish water of estuaries and salt marshes. Girdler sand, Thames, and at Tweedmouth (*Mr. E. C. Davison*); in salt marshes at Hylton on the Wear, Jarrow on the Tyne, Seaton Sluice, and at the mouths of the Wansbeck and Alne, Northumberland (*G. S. B.*).

The great similarity between this and the foregoing species caused me, until very recently, to regard the one as a merely littoral or brackish-water variety of the other. I have been induced to alter that opinion, chiefly by finding, in a gathering from the Girdler sand in the estuary of the Thames, the two forms living together abundantly, and retaining very perfectly their distinctive characters. The points which may be chiefly relied on as characterizing *C. castanea* are, the more arcuate dorsal margin and greater comparative height of the female, the median position of the greatest width of the carapace, and, in the male, the perfectly straight dorsal margin, and much-narrowed hinder extremity—lastly, the sculpture of the shell-surface, which consists of closely set rounded (not oblong) impressions. The list of habitats here given is doubtless very imperfect; the species must often have been passed by without special notice as a form of *C. pellucida*.

5. Cythere tenera, n. sp. (Plate XXVIII. figs. 29–32.)

British type. Distribution: *Recent*—Great Britain, Bay of Biscay. *Fossil*—Glacial, Norway.

Carapace of *female* almost exactly similar in form to *C. pellucida*, but much smaller, the superior margin somewhat more arched; the surface smooth and having no trace of any transverse sulcus. The shell is very closely and delicately punctate, and bears a few distant and minute elevated papillæ. The length is rather more than twice the height. The outline as seen from above is regularly ovate. Animal unknown. Colour white. Shell of the *male* narrower, and tapered posteriorly.

Length $\frac{1}{55}$ in.

Hab. Off Seaham Harbour, Durham, 15 fathoms (*G. S. B.*); Race's bank and Girdler sand, Thames (*Mr. E. C. Davison*); the Minch (*Rev. A. M. Norman*); Shetland (*Mr. D. Robertson*).

This species is easily distinguished from *C. pellucida* by its much smaller size, very fine punctation, and absence of furrowing. There can, I think, be no doubt of its specific rank: all the specimens I have seen are uniform in size, and I have observed no forms intermediate in character between it and either of the two preceding species. The young of *C. pellucida*, even in their very early stages, are quite coarsely punctate, and those of *C. castanea* are mostly also of dark colour.

6. Cythere badia, Norman. (Plate XXIX. figs. 56–59.)

Cythere badia, Norman, Ann. & Mag. Nat. Hist. vol. ix. (1862) p. 48, pl. iii. figs. 13–15.
—— *cicatricosa*, Sars, *loc. cit.* p. 33.
? —— *canaliculata*, Brady, Trans. Zool. Soc. vol. v. p. 373, pl. 59. fig. 4 *a–f*.

British type. Distribution: *Recent*—Norway, Great Britain and Ireland, Mediterranean, Australia?
Fossil—Raised beaches and glacial clays, Norway, Scotland, and Ireland.

Carapace oblong, reniform. Seen from the side, the valves are rather higher in front than behind, the height a little more than equal to half the length. Anterior margin broadly rounded, posterior slightly rounded, subtruncate; dorsal margin very slightly arched, sloping gently backwards, ventral conspicuously incurved in front of the middle. Outline, as seen from above, compressed, ovate, breadth equal to more than one-third of the length; anterior extremity obtusely pointed, posterior more rounded. End view oval. Surface of the shell uneven, marked with irregular furrows and elevations. Hinge-joint well developed. Colour deep yellowish brown. One eye. Antennæ short and thick, last joint of the upper equal in length to the preceding. Second joint of the last pair of feet scarcely longer than the united length of the two following; terminal claw short and thick.

Length $\frac{1}{50}$ in., height $\frac{1}{100}$ in.

Hab. In rock-pools at Mount's Bay, Cornwall, Herm, Guernsey, Arran, and Loch Carron, N. B. (*Rev. A. M. Norman*); in shell-sand, Roundstone (*Dr. Alcock*), Birterbuy Bay, 15 fathoms, and amongst oyster-ooze from Stranraer (*G. S. B.*); dredged in the Minch, 45–60 fathoms (*Mr. J. G. Jeffreys*); Cumbrae (*Mr. D. Robertson*); Scarpa Flow, Orkney (*Mr. E. C. Davison*).

C. badia is one of the less-common British species; in outline it is not very unlike *C. pellucida*, but much smaller.

7. Cythere oblonga, Brady. (Plate XXXI. figs. 14–17.)

Cythere oblonga, Brady, Trans. Zool. Soc. vol. v. p. 373, pl. 59. figs. 5 *a–d*.

Mediterranean type. Distribution: *Recent*—England, Bay of Biscay, Mediterranean.

Carapace, as seen from the side, oblong, subquadrangular, equal in height throughout, height equal to nearly half the length. Anterior margin obliquely rounded, minutely and numerously dentate, posterior truncate and angular; superior margin straight or very slightly curved, inferior nearly straight in front, behind irregularly emarginate or obsoletely toothed. Seen from above, the outline is ovate, greatest breadth equal to much more than one-third of the length; extremities obtusely rounded; hinge-margins depressed behind the middle. Surface irregularly marked with deep angular pittings of very variable size; a well-marked tubercle over the anterior hinge. Within the anterior margin is usually a raised crenulated ridge, which is marked with radiating transverse hair-like lines. Colour yellowish brown. Animal unknown.

Length $\frac{1}{29}$ in., height $\frac{1}{62}$ in.

Hab. In shell-sand, Mumbles (South Wales).

** *Mandibular palp four-jointed, bearing on its inner margin three strong, curved, plumose setæ; last joint linear, slender.*

α. Urticating seta long in male, short in female.

8. Cythere rubida, n. sp. (Plate XXXII. figs. 71–74.)

Carapace of the *female*, as seen from the side, subreniform, highest in front of the middle, greatest height equal to more than half the length. Extremities rounded, the anterior much the broader; superior margin highest above the eye, whence it slopes

backwards almost in a right line; inferior deeply sinuated in the middle. Outline, as seen from above, subhexagonal, widest in the middle, sides nearly parallel and tapering equally to each extremity, greatest width equal to half the length. End view subtriangular, height much greater than the width, prominently keeled. The central portion of the valves is covered with a thick reddish incrustation, and closely and irregularly pitted; this central elevated portion is surrounded by a broad flattened margin, which is devoid of pittings, but is marked, especially in front, by radiating lines. The two eyes are plainly visible through the shell, forming brilliant black spots. Upper antennæ strongly spinous, last joint shorter than the preceding. Flagellum of lower antenna very short, scarcely reaching the middle of the penultimate joint. Mandibular palp four-jointed, armed with three stout curved plumose setæ as in *C. albomaculata* &c., terminal joint slender. Legs short, and nearly equal, terminal claws long and curved; second joint of last pair not so long as the two following joints, claw not ciliated. Post-abdominal lobes terminating in two ciliated setæ. Male unknown.

Length $\frac{1}{42}$ in.

Hab. In rock-pools, Clackland Point, Arran, N.B. (*Rev. A. M. Norman*).

This is a very interesting species, as combining the outward form of a typical *Cythere* with the anatomical characters of the group usually classed under *Cythereis*. The other two intermediate species, *C. albomaculata* and *C. convexa*, are somewhat abnormal both in external and internal structure, and might, with some show of reason, have been erected into independent genera between *Cythere* and *Cythereis*; but *C. rubida* being outwardly a true *Cythere*, and anatomically a true *Cythereis*, seems conclusively to prove the expediency of amalgamating the two genera.

9. Cythere convexa, Baird. (Plate XXIX. figs. 19–27, and Plate XXXIX. fig. 4.)

Cythere convexa, Baird, Brit. Entom. p. 174, tab. xxi. fig. 3.
—— *arborescens*, Brady, Ann. & Mag. Nat. Hist. 1865, vol. xvi. pl. ix. figs. 5–8.
?*Cypridina cicatricosa*, Reuss, Haidinger's Abhandl. Band iii. (1850) fol. 67, tab. ix. fig. 21.
?*Cythere cicatricosa*, Bosquet, Entom. fossil. des terr. tertiair. de la France, p. 76, tab. iii. fig. 13.
Cythere punctata, Jones, Entom. of Tert. Form. Eng. p. 24, pl. ii. figs. 5*a*–5*h*.

British type. Distribution: *Recent*—Great Britain, Ireland, Bay of Biscay, Levant. *Fossil*—Glacial clay and raised beaches, England, Scotland, and Ireland; crag, England; and tertiary, Germany and Sicily.

Shell rounded, convex, beaked behind, slightly keeled in front and below; greatest height in the middle, equal to about two-thirds of the length; the left valve much larger than the right, and overlapping considerably on the dorsum. Seen from the side, the anterior margin is rounded, posterior beaked, and expanded below the beak into three or four squamous spines (figs. 19, 25, 27). Ventral margin slightly convex, sinuated at the anterior third, and curved upwards behind, where it also frequently bears one or two spines, which project downwards. Dorsal margin boldly arched, highest in the middle. End view oval, tumid, widest in the middle, pointed above and below. Outline, as seen from above, oblong oval, widest in the middle, and tapering equally to each extremity, width equal to half the length. The hinge-processes, with the intermediate bar and

furrow, are strongly developed (figs. 23, 24). The surface of the shell varies much in character; well-marked adult specimens are mostly marked with deep pittings, which are concentrically arranged, and are deepest and closest round the margins of the valves, especially on the ventral surface, where they are liable to form longitudinal furrows. But some varieties exhibit only slightly impressed punctures, and in very old specimens the excavations are more or less obliterated by calcareous deposit. The right valve, besides being much smaller than the left, is likewise very different in shape, being prominently beaked behind, somewhat truncate above, and deeply sinuated on the ventral margin. The terminal claws of the lower antennæ are very short, slender; and there is an armature of three setæ on the middle of the inner margin, similar to that of the following species, but without the pectination of the long filament. The urticating seta is very short in the female (see Plate XXXIX. fig. 4).

Length $\frac{1}{30}$ in., height $\frac{1}{50}$ in.

Hab. In deep water and occasionally between tide-marks. Scarpa Flow, Orkney (*Mr. E. C. Davison*); the Minch (*Mr. J. G. Jeffreys*); Isle of Skye, Lamlash Bay, Channel Islands, Falmouth, Burrow Island, Swansea, Youghall (*Rev. A. M. Norman*); in tidal pools in the Isle of Man, dredged off Shetland, Lerwick, Cumbrae, and Oban (*Mr. D. Robertson*), off Devonshire coast, 60 fathoms (*Mr. C. S. Bate*); in shell-sand from South Wales and Stranraer, Aran, and Roundstone, and dredged in Birterbuy Bay (*G. S. B.*); "Torquay, in sand, *W. C. Williamson, Esq.*; Tenby, in sand, *T. R. Jones, Esq.*" (*Dr. Baird*).

β. Urticating setæ long and slender in both sexes.

10. Cythere albomaculata, Baird. (Plate XXVIII. figs. 33–39, and Plate XXXIX. fig. 3.)

Cythere albomaculata, Baird, Brit. Entom. p. 169, tab. xx. fig. 7.
—— *alba* (young), Baird, *loc. cit.* p. 170, tab. xx. fig. 6.

British type. Distribution: *Recent*—Great Britain, Ireland, Norway, Bay of Biscay, Levant, Cape Verd. *Fossil*—Glacial clays and raised beaches, Scotland, Ireland, Norway.

Valves, as seen from the side, oblong, subreniform, nearly equal in diameter throughout; height equal to rather more than half the length. Anterior margin well rounded; posterior obliquely rounded, and somewhat angular at its junction with the ventral border. Dorsal margin forming a flattened arch; ventral margin deeply incurved at its anterior third, and curving upwards behind. Outline, as seen from above compressed, oblong, widest in the middle, and gradually tapering to the extremities, which are pointed, width equal to more than one-third of the length. End view oval, rounded above and keeled below. The valves are bordered in front and below by a broad, flattened flange or belt, which is marked with thickly set, transverse, hair-like lines (fig. 38). The striated keel thus formed by the junction of the two valves is very conspicuous on the ventral and anterior aspects of the shell (figs. 35, 36). Surface smooth and polished, clothed with short scattered hairs; pellucid and marked with patches of black or olive-green; old specimens and those from shell-sand and deep water are mostly opaque white. The hinge-joint is exceedingly well developed, the left valve bearing a strong bar which is received into a groove between the terminal processes of the opposite valve (fig. 39).

Lucid spots about eight in number, subquadrangular, and arranged in two irregular transverse rows. Two small shining eye-tubercles. Superior antennæ robust, five-jointed, second joint short, not much more than equal in length to the two succeeding; last joint short; terminal spines strong, curved. Inferior antennæ robust, last joint short and truncate, terminal claws rather short and slender; urticating seta reaching to about the apex of the limb, equal in the male and female; penultimate joint, in the male, deeply emarginate about the middle of the posterior margin and bearing three setæ, one of which is short and slender, the central one longer and strongly pectinate, the other very short and club-shaped (see Plate XXXIX. fig. 3*b*). This arrangement is similar in the female, but all the parts are feebly developed. Second joint of the last foot not much longer than either of the two succeeding joints. Terminal claw long and strong. Abdominal lobes truncate, each bearing two ciliated terminal setæ. Eyes two. Basal portion of the male copulative organs very large, quadrate; apex acute and tapering.

Length $\frac{1}{27}$ in., height $\frac{1}{50}$ in.

Hab. Littoral and in moderate depths up to 15 fathoms. In shell-sand from Walton and Whitstable (*Prof. T. Rupert Jones*); Orkney, Girdler sand (Thames), Margate, and Cork (*Mr. E. C. Darison*); Shetland, Loch Carron, Arran (N.B.), Tobermory, Youghall, Exmouth, Burrow Island, Guernsey, dredged and living in tide-pools (*Rev. A. M. Norman*); Isle of Man, at roots of Laminariæ, and Cumbrae, Macduff, and Peterhead (*Mr. D. Robertson*); Aberdeenshire coast (*Mr. Dawson*); Galway, Roundstone, and Birterbuy Bay (dredged), and abundantly in rock-pools at Arranmore, and on the Durham coast, and in shell-sand from the Mumbles and Stranraer (*G. S. B.*); Norfolk coast, dredged (*Mr. D. O. Drewett*).

The form described by Dr. Baird under the specific name *alba* (see fig. 38*a*) seems to be the young of *Cythere albomaculata*. *C. strigulosa*, Reuss, is very closely allied to, but (according to specimens named by M. Bosquet) not identical with the present species. *C. albomaculata* differs remarkably from most of those with which it is associated, in the form and structure of the shell, the peculiar armature of the second antennæ, and the structure of the mandibular palp, the latter being quite similar to the form observed in the following section, which includes the species usually classed under the genus *Cythereis*. These differences, though important, do not seem so much so as to warrant the formation of an independent genus for this species. It is probably the most abundant and most widely distributed of the British marine Ostracoda, being found all round our coasts from high-water mark to a depth of about 15 fathoms. Very remarkable is its apparent absence from the Scandinavian and other shores of continental Europe; for, being a large and conspicuous species, it can scarcely have escaped detection by such naturalists as have recently investigated this group*. Should further observation show that its distribution is confined to the British Islands, it will be a most interesting, and perhaps a unique example of a purely British species having attained almost a predominant position in its own district as to range and numbers. It occurs in the glacial clays of this country, but I am not aware whether it has been found in those of Norway.

* Since this was in the printer's hands, I have seen a few specimens dredged by Mr. D. Robertson off the coast of Norway, and others from the Mediterranean.

11. Cythere pulchella, nov. sp.

Arctic type. Distribution: *Recent*—Scotland, Baffin's Bay. *Fossil*—Scotland, glacial clay.

Carapace of female, viewed laterally, subreniform, greatest height in front of the middle and equal to considerably more than half the length; anterior extremity broadly rounded, posterior obliquely subtruncate, scarcely rounded; superior margin highest over the eyes, thence sloping backwards with a gentle curve, inferior sinuated in the middle; outline, as seen from above, ovate, widest behind the middle, greatest width equal to nearly one-half the length, extremities pointed. Surface of the shell closely punctate. Hinge-teeth of the right valve forming two projecting crests, which end abruptly at the terminal extremities, but slope gradually towards the middle of the hinge-line, and are crenulated on their edges. Upper antennæ armed at the apices of the last four joints with slender, slightly curved spines, third and fourth joints coalescent; flagellum of the lower antenna biarticulate, alike in male and female. Mandibular palp bearing three curved pectinate setæ (as in *Cythereis*, Sars). Feet short and stout, their terminal claws much dilated at the base, nearly straight in the middle, and suddenly curved (almost hooked) at the apex.

Length $\frac{1}{46}$ inch.

This species is not very unlike *C. villosa* in general appearance, but is smaller, less compressed from side to side, with more rounded outlines and a much finer surface-ornament. The only recent British specimen I have seen is one, apparently immature, which occurred in some shell-sand gathered by Mr. D. O. Drewett in Respond Bay, Loch Erribol, N.B. It occurs more plentifully in some of the Scottish glacial formations, and will be fully figured in a forthcoming work on the Posttertiary Entomostraca. Mr. Crosskey has also found it abundantly in some recent gatherings from Davis's Straits; and from these specimens the anatomical details above given have been derived.

b. *Carapace, as seen from the side, quadrilateral, highest in front, ventricose, often prominently rugose or spinous.*

* *Mandibular palp three-jointed, simply setose. Urticating setæ equal in the male and female.*

12. Cythere cuneiformis, Brady. (Plate XXXI. figs. 47–54.)

Cythere ventricosa, Sars, *loc. cit.* p. 34.

British type. Distribution: *Recent*—Great Britain, Ireland, Norway. *Fossil*—Glacial clays and raised beaches, Scotland and Norway.

Carapace subprismoid, depressed behind, acutely angular on the dorsal and slightly convex on the ventral surface. *Female*, as seen from the side, subclavate, greatest height at the anterior third, and equal to about half the length; anterior extremity broadly and obliquely rounded, posterior obtusely pointed (in the adult). Superior margin nearly straight and gently sloping as far as the posterior fourth, thence sloping steeply to the extremity; inferior margin straight, or irregularly sinuated. Outline, as seen from above, ovate, acuminate behind, obtusely pointed in front; greatest width behind the middle, equal to nearly half the length. End view triangular, the base slightly convex. Surface

faintly pitted or papillose, transversely sulcate near the middle, longitudinally rugose on the ventral surface. Hinge-processes feebly developed; left valve minutely crenulate. Carapace of the *male* more elongate, superior margin slightly concave. Colour yellowish. "One eye. Antennæ short, last joint of the upper shorter than the preceding. Second joint of the last pair of feet about equal to the united length of the two following joints, terminal claw long and slender. Basal portion of the male copulative organs narrow above, apical portion subtriangular."

Length $\frac{1}{40}$ in., height $\frac{1}{95}$ in.

Hab. Dredged in the Minch, 45–60 fathoms, and near Guernsey in 15–30 fathoms (*Mr. J. G. Jeffreys*); Roundstone Bay, 2–3 fathoms, and Northumberland coast, 45 fathoms (*G. S. B.*); Cumbrae (*Mr. D. Robertson*); in shell-sand from Galway (*Prof. Rowney*).

The specific name *ventricosa* being preoccupied by Reuss, I have here adopted the term *cuneiformis*, which I had applied to the species in MS. before seeing the work of G. O. Sars.

13. Cythere limicola (Norman). (Plate XXXI. figs. 38–41.)

Cythereis limicola, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 20, pl. vi. figs. 1–4.
Cythere nodosa, Sars, *loc. cit.* p. 34.
? —— *complexa*, Brady, Brit. Assoc. Report, 1866, p. 210.
—— *areolata*, Brady, Trans. Zool. Soc. vol. v. p. 381, tab. lxii. figs. 2*a–d*.

Scandinavian type. Distribution: *Recent*—Baffin's Bay, Norway, Great Britain. *Fossil*—Glacial clay and raised beaches, Scotland.

Carapace short, tumid, quadrangular; length to height as about three to two, not much higher in front than behind. Seen from the side, the anterior margin is well rounded below and slopes very steeply backwards above, terminating in an elevated angle over the anterior hinge. Posterior margin somewhat angular in the middle, slightly rounded below, and sloping nearly in a right line upwards to the dorsum, its junction with which is marked by an angular projection; the dorsal margin, between this and the anterior angle, is considerably hollowed. Ventral margin rather sinuous. The outline as seen from above is hexagonally cuneate or boat-shaped, very broad behind, and tapering abruptly at each extremity; greatest breadth near the posterior extremity, equal to more than half the length. End view triangular, with an excessively convex base; outline irregularly sinuous. Surface of the shell rugose, tuberculated, and marked with fine closely set puncta; the general direction of the rugæ is in curved transverse lines; but the most conspicuous elevation runs longitudinally at a little distance within the ventral margin: there are two very large tubercles or nodules on the dorsal aspect of each valve near the posterior angle, and one in the situation of the anterior hinge-joint. Colour brownish yellow. "No eyes. Antennæ elongated, last joint of the upper elongated, linear, and somewhat shorter than the preceding; third joint of the lower antennæ more slender than usual. Feet slender and elongated; second joint in the last pair a little shorter than the united length of the two following, terminal claw long and almost straight. Basal portion of the male copulative organs small and rounded, apical portion

subtriangular; anterior extremity lengthened into a slender and obtusely pointed process."

Length $\frac{1}{42}$ in., height $\frac{1}{75}$ in.

Hab. In deep water. Isle of Skye and Northumberland and Durham coasts (*Rev. A. M. Norman*); Oban (*Mr. D. Robertson*); Aberdeenshire coast (*Mr. Dawson*).

This species appears to live altogether amongst soft mud, in which it burrows, whence probably, as Sars observes, the entire absence of eyes. Like the preceding species it is of rare occurrence in the British seas; and Sars makes the same remark respecting its Norwegian distribution. It occurs also in the Scotch glacial clays. I now believe that the form described by me as *C. complexa* is merely the young of *C. limicola* (see figs. 43–46).

14. Cythere globulifera, n. sp. (Plate XXXI. fig. 42.)

Valves, as seen from the side, oblong, subrhomboidal, rather higher in front than behind; greatest height equal to more than half the length. Extremities rounded, the posterior rather narrowed; superior margin straight, gibbous over the anterior hinge; inferior slightly convex, curved upwards behind. Surface marked with a fine ribbed reticulation and bearing four prominent rounded tubercles, three below the dorsal and one above the anterior extremity of the ventral margin; the shell is swollen below and behind the middle into a rounded elevated ridge or ala.

Length $\frac{1}{58}$ in.

Hab. Roundstone, in shell-sand.

Of this species I have seen only one specimen, and that a single valve; but its characters are so very different from those of any described form, that I have thought it best to describe it here under a specific name; it is nevertheless possible that it may prove to be an immature form of some other species*.

** *Mandibular palp four-jointed, last joint slender; inner margin bearing three strong, curved, plumose setæ. Urticating setæ much shortened in the female.*

15. Cythere tuberculata (Sars). (Plate XXX. figs. 25–41.)

Cythereis tuberculata, G. O. Sars, *loc. cit.* p. 37.

Cythere mutabilis, Brady, Trans. Zool. Soc. vol. v. p. 377, pl. lix. figs. 12–14.

British type. Distribution: *Recent*—Baffin's Bay, Great Britain, Ireland, Norway, Bay of Biscay, West Indies. *Fossil*—Glacial clays and raised beaches, England, Scotland, Ireland, and Norway.

Shell of the *female*, as seen from the side, elongate quadrangular, highest in front; greatest height equal to more than half the length; a large rounded tubercle in front of the centre, and two elongated tubercles or ridges, one ventral and one dorsal, near the hinder extremity; these last are very conspicuous in young specimens, but become

* Since writing this, I have had the opportunity of examining several specimens, apparently referable to this species, which have been found by Messrs. Crosskey and Robertson in the course of their researches amongst the Scottish glacial clays.

almost obsolete in the adult, forming a mere transverse tumid elevation of the valve. The anterior margin is broad, well rounded below, and more gradually curved above, where it terminates in a rounded elevation over the anterior hinge. The posterior margin is narrowed, and rather abruptly angular in the middle. Ventral margin nearly straight, or gently incurved in the middle: dorsal elevated over the anterior hinge, thence sloping in an undulating line to the posterior extremity. Seen from above, the carapace is ovate, broadest behind, width somewhat less than the height; extremities obtuse, outline very irregularly undulated; no eye-tubercle. End view irregularly quadrate, somewhat tapering above. Hinge-processes of the right valve strongly developed; of the left obsolete (fig. 29). Surface marked with large and deep pittings, often interspersed with much smaller ones, and, in the intervals, bearing elevated papillæ. Anterior border mostly fringed with a series of from five to twenty, and the posterior extremity with about six teeth; but these are often entirely absent. Colour yellowish brown. Limbs deep yellow. Shell of the *male* much elongated, length more than twice the height, upper margin slightly concave behind the anterior hinge (fig. 30). Upper antennæ six-jointed, last joint a little longer than the preceding. Urticating seta very slender. Claw of first foot pectinate on its inner margin. Second joint of last foot rather longer than the united length of the two following joints, terminal claw very long and slender. Male copulative organs produced into a much elongated and slender process in front, the apical portion forming two prolongations, the anterior obtusely hooked, the posterior acuminate.

Length $\frac{1}{25}$ in.

Hab. 1–60 fathoms, Hebrides and the Minch, Shetland and Channel Islands (*Mr. J. G. Jeffreys*); Oban, Bute, Campbeltown, and Cumbrae (*Mr. D. Robertson*); Dogger bank, Exmouth, Plymouth, Isle of Skye, and Tobermory (*Rev. A. M. Norman*); Orkney (*Mr. C. W. Peach*); Northumberland and Durham coasts, 20–46 fathoms, and in oyster-ooze from Stranraer and South Wales (*G. S. B.*); Aberdeenshire coast (*Mr. Dawson*); Roundstone (*Dr. Alcock*); Devonshire coast (*Mr. C. S. Bate*); in shell-sand from Baltimore, Frith of Forth, and Margate (*Mr. E. C. Davison*).

The characters upon which I rely to distinguish this fine species are the *central tubercle*, which is never, so far as I know, entirely wanting; the *two posterior tubercles*, or, in old specimens, the transverse elevation resulting from their coalescence, which gives to the dorsal view a somewhat cuneate outline; and the absence mostly of any conspicuous tubercle over the anterior hinge, and of any well-defined longitudinal sulcus on the dorsal aspect. But, even thus restricted, there is great variety in the different forms of carapace, as will be sufficiently seen by reference to the figures in Plate XXX. The smooth but prominently tuberculated character of young specimens is shown in figs. 38–39, while the gradual disappearance of the tubercles and consentaneous development of the minor surface-markings may be traced upwards in figs. 37, 36, 30, 24, and 25; finally, fig. 32 shows a still older form, in which the surface-markings have become partially obliterated by calcareous deposit, as has been previously described in the case of other species.

16. CYTHERE CONCINNA, Jones. (Plate XXVI. figs. 28–33, and Plate XXXVIII. fig. 7.)

Cythere concinna, Jones, Tert. Entom. p. 29, pl. iv. figs. *7a–7f*.
Cythereis clavata, Sars, *loc. cit.* p. 39.

Scandinavian type. DISTRIBUTION: *Recent*—Great Britain, Norway. *Fossil*—Crag, England; glacial clays and raised beaches, Scotland, Ireland, and Norway.

Valves, as seen from the side, oblong, quadrangular, higher in front than behind; length equal to twice the height. Anterior extremity rounded, posterior rectangularly or obliquely truncate, and slightly sinuated. Ventral margin nearly straight; dorsal sloping in a right line, or gently arched, highest over the anterior hinge. Outline, as seen from above, oblong quadrangular, twice and a half as long as broad, with nearly parallel, sinuous sides, and broadly rounded extremities; the hinge-margins rather depressed behind the middle. Anterior and inferior surfaces longitudinally furrowed. The surface of the shell is marked (in highly sculptured specimens) with thickly set small punctations, and on the posterior half with a network of fine ribs; but very commonly the surface is only slightly and irregularly undulated, bearing a few short scattered setæ—or sometimes roughened and studded with a few small tubercles, as shown in fig. 32. Within, and parallel to, the anterior and ventral margins runs an elevated ridge; and there are also, in most cases, two shorter oblique ridges on the posterior portion of the valve, a well-marked rounded tubercle in front of the middle, and another over the anterior hinge. The hinge-processes are well-developed, the posterior being placed very far back at the extreme dorsal angle. Colour yellowish. Last joint of the upper antennæ elongated, much longer than the preceding. Second joint of the last pair of feet about equal in length to the united lengths of the third and fourth joints; terminal claw exceedingly slender, almost setiform. Terminal claw of first foot pectinate.

Length $\frac{1}{28}$ in., height $\frac{1}{55}$ in.

Hab. The Minch and Hebrides, 45–60 fathoms (*Mr. J. G. Jeffreys*); Orkney (*Mr. C. W. Peach*); dredged in 6–10 fathoms, Campbeltown Bay, Argyleshire, and Ormeshead (*Mr. D. Robertson*); off Scarborough (*Mr. Leckenby*); off Lewis, N.B., 59½ fathoms (*Admiralty Soundings*); Roundstone (*Dr. Alcock*).

The sculpturing of the valves in this species is variable. The specimen from which figs. 28–31 were drawn represents the best developed condition of surface-marking; the ribs and tubercles are often much less conspicuous. Fossil specimens described by Prof. T. Rupert Jones are very slightly sculptured, a condition shown in fig. 32; those found in the Scottish glacial clay by Messrs. Robertson and Crosskey are often strongly marked in the coarser surface-characters, but, in most cases, have comparatively little of the delicate ribbing and punctation seen in some recent specimens. This, however, is one of the most abundant of the Scotch Glacial Entomostraca, and shows a great range of variation. Recent specimens dredged by Mr. Jeffreys in the Minch and the Sound of Skye, at a depth of about 60 fathoms, also vary considerably, and are identical in appearance with the majority of the fossil specimens. Those dredged further south by Mr. Robertson, in shallower water, are usually more highly ornamented (figs. 28–31), and are less frequently met with in a fossil state. For more copious illustrations of the

varieties of this fine species, I must refer the reader to a Monograph of the Posttertiary Entomostraca which is in preparation for the Palæontographical Society.

17. CYTHERE ANGULATA (Sars). (Plate XXVI. figs. 39–42.)

Cythereis angulata, Sars, *loc. cit.* p. 40.

Scandinavian type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Great Britain. *Fossil*—Glacial and raised beaches, Scotland and Norway.

Carapace, as seen from the side, oblong, quadrilateral, greatest height near the front, and equal to more than half the length. Anterior margin rounded below and sloping steeply backwards above; posterior narrower, rectangularly truncate, and somewhat protuberant below the middle; ventral margin nearly straight, dorsal sloping backwards in a straight or gently curved line from the anterior hinge. Outline, as seen from above, very irregular, somewhat lozenge-shaped, tapering slightly towards the front, which is very obtuse or almost truncate, the sides parallel and constricted in the middle; posterior extremity broadly and obtusely mucronate, greatest width equal to less than half the length, the hinge-margins forming at their junction a narrow, sharply cut longitudinal sulcus. End view broadly ovate; deeply constricted above the middle; broad above, sharply keeled below. Surface irregularly undulated and marked with angular excavations of variable size; a conspicuous rounded tubercle near the anterior hinge, and another large rib or elongated tubercle near the centre of the valve; a sharply defined transverse ridge terminates the sculptured portion of the shell, beyond which the posterior portion projects on a lower level. The right valve is rather smaller and more angular than the left, and the dorsal margin is more depressed. Colour brown. "Third and fourth joints of the upper antennæ confluent, the last short and armed with a strong spine. Second joint of the last foot much shorter than the two following. Copulative organs of the male small, apical portion obtuse, subhamate."

Length $\frac{1}{37}$ in., height $\frac{1}{75}$ in.

Hab. The Minch, 45–60 fathoms (*Mr. J. G. Jeffreys*); Shetland, Lerwick, Cumbrae, Macduff Harbour, and Peterhead (*Mr. D. Robertson*); Scarpa Flow, Orkney (*Mr. E. C. Davison*).

This is very distinct from any other recent British species, and is apparently one of the rarest. Sars notes that specimens from Finmark are much larger and more abundant than those found by him in Christianiafiord; he therefore infers that it is a peculiarly northern species. It occurs in the glacial clays of Scotland and Norway.

18. CYTHERE DUBIA, n. sp. (Plate XXXII. figs. 75, 76.)

Carapace, as seen from the side, subquadrangular, highest in front, greatest height equal to more than half the length. Anterior extremity rounded, posterior obliquely subtruncate, angulated about the middle, below which are three small teeth; superior margin slightly convex, sloping almost in a straight line to the posterior extremity, where it forms an abrupt angular projection; inferior deeply sinuated in front of the middle. Seen from above, the outline is irregularly subovate, about twice as long as broad; sides

nearly parallel, anterior extremity obtuse, the posterior broadly mucronate. Surface of the shell uneven, vaguely marked with ill-defined pits and furrows.

Length $\frac{1}{27}$ in.

Hab. Shetland (*Rev. A. M. Norman*).

Mr. Norman's collection contains one specimen only of this species. It is nearly allied to *Cythereis emarginata*, Sars, but is very much larger, and has not the sharply defined reticulated sculpture of that species; the outline is also more irregular.

19. Cythere finmarchica, Sars. (Plate XXXI. figs. 9–13.)

Cythereis Finmarchica, Sars, *loc. cit.* p. 41.

Scandinavian type. Distribution: *Recent*—Norway, Great Britain, Ireland, Bay of Biscay, Cape Verd. *Fossil*—Glacial, Scotland.

Valves, as seen from the side, oblong quadrangular, rather higher in front than behind; length equal to twice the height. The anterior border is obliquely rounded and angulated at its junction with the dorsum, often slightly toothed below. Posterior extremity flattened and narrow, produced below, where it is divided into about four broad, blunt teeth. Inferior margin straight or slightly incurved. Dorsal margin very slightly arched, or sloping almost in a straight line from before backwards. Seen from below, the outline is oval, with obtuse extremities and parallel sides, which are sometimes rather deeply sulcate in the middle. End view subtriangular, broad, and rounded below, tapering above. The surface is marked with numerous rather large, shallow pits, and is often transversely sulcate; in front of the median sulcus is a large rounded tubercle bearing the lucid spots, which are nine to twelve in number, and irregular in arrangement (figs. 9, 13). Animal unknown.

Length $\frac{1}{38}$ in., height $\frac{1}{80}$ in.

Hab. Dredged off Oban (*Mr. D. Robertson*); Roundstone, in shell-sand (*Dr. Alcock*); Galway Bay, in shell-sand (*Prof. Rowney*); The Minch and Channel Islands, 15–30 fathoms (*Mr. J. G. Jeffreys*); Northumberland coast, 46 fathoms (*G. S. B.*); Devonshire coast (*Mr. C. Spence Bate*); in tide-pools, Herm (*Rev. A. M. Norman*).

I at one time supposed this species to represent merely a stage of growth or a local variety of *C. tuberculata*; but this opinion I now believe to be untenable. The elongated form of the valves (without tumidity behind), the posterior crenulation, and the *one* central tubercle are constant characters. It will be seen, by reference to Plate XXX., that the young forms of *C. tuberculata* always exhibit one central and *two posterior* tubercles; and the teeth of the posterior margin, when they exist at all, are really outgrowths of the shell, and not mere indentations of the bordering lamina as in the present species. Moreover the anterior border of well-grown specimens of *C. tuberculata* is almost sure to be fringed with spines, but in *C. finmarchica* is either entire or, at most, slightly crenated, as shown in fig. 9.

20. CYTHERE VILLOSA (Sars). (Plate XXIX. figs. 28–32).

Cythereis villosa, Sars, *loc. cit.* p. 42.

British type. DISTRIBUTION: *Recent*—Great Britain and Ireland, Norway, Bay of Biscay. *Fossil*—Glacial clays and raised beaches, Scotland, Ireland, Norway.

Carapace of the *female*, as seen from the side, oblong quadrangular, nearly equal in height throughout; greatest height equal to more than half the length. The anterior margin is obliquely rounded; the posterior truncate, angular, and somewhat waved. The dorsal margin forms a flattened arch; ventral margin straight or slightly sinuated, swelling near the posterior, and sometimes also near the anterior extremity into an angular protuberance. The outline, as seen from above, is compressed oblong, its sides nearly parallel and tapering suddenly at each extremity, width equal to more than one-third of the length; the contact-margins bordered by prominent ribs. End view ovate, narrowed above. Hinge-joints as in *C. albomaculata*. The surface of the shell is marked with large and deep excavations, which tend to coalesce, and form, especially towards the ventral and posterior borders, irregularly waved ribs and furrows. There is, however, much variety in the amount and character of the sculpture, as well as in colour, which ranges from white or yellow to a deep slaty blue. The form and proportions of the carapace are also very variable, though the essential characters of the species are mostly well preserved. The *male* is much elongated, about twice as long as high. Animal almost exactly similar to that of *C. angulata*. The second antenna has an armature of three setæ similar to that of *C. convexa*.

Length $\frac{1}{42}$ in.

Hab. Littoral and in deep water. Shetland, Tobermory, Berwick, Isle of Skye, Plymouth, Exmouth, Youghal, alive in tidal pools at Herm, Lamlash Bay, and Loch Carron (*Rev. A. M. Norman*); Orkney (*Mr. C. W. Peach*); Aberdeenshire coast (*Mr. Dawson*); Cumbrae, Macduff, Peterhead, Lerwick, and Oban (*Mr. D. Robertson*); Cowes, Margate, Girdler sand and Donegal Bay (*Mr. E. C. Davison*); the Minch and Channel Islands (*Mr. Jeffreys*); Devonshire coast (*Mr. C. S. Bate*); Norfolk coast (*Mr. D. O. Drewett*). In shell-sand from South Wales, Stranraer, Galway Bay, and Roundstone; dredged in Birterbuy Bay, 15 fathoms, and Northumberland coast, off Holy Island, 45 fathoms (*G. S. B.*).

This species, like *C. convexa*, is almost exclusively confined to the laminarian zone, the instances of its occurrence in a living state between tide-marks being comparatively rare. It appears to be a common species in our seas, except on the eastern coast, where it is rare—in this respect, also, agreeing with *C. convexa*. It occurs plentifully in the Glacial clays of Scotland and Norway.

21. CYTHERE ? SEMIPUNCTATA, n. sp. (Plate XXIX. figs. 33–37.)

DISTRIBUTION: *Recent*—Ireland, Bay of Biscay.

Carapace of the *male* (?), as seen from the side, subelliptical, rather higher in front than behind; greatest height equal to more than half the length; extremities rounded; superior margin nearly straight in front, gently curved behind; inferior slightly sinuated; margins at their outermost edge thickened and elevated, but depressed inwardly, thus forming a shallow excavated channel round the anterior and ventral portions of the

valve. Outline, as seen from above, compressed, subquadrangular, width equal to one-third of the length; sides parallel, anterior extremity narrowed, truncate; posterior broader, slightly rounded. Surface of the shell covered behind the middle with closely set circular pits. Colour yellowish. Animal unknown.

Length $\frac{1}{45}$ in.

Hab. Birterbuy Bay, dredged (*G. S. B.*); Roundstone, in shell-sand (*Dr. Alcock*).

The valves represented at figs. 36 and 37 belong apparently to the young of this species, are slightly sulcate across the middle, and exhibit the semipunctate character of the species very plainly. Several examples of single valves occurred in Dr. Alcock's shell-sand, but only one perfect carapace in my dredgings from the same locality.

22. Cythere Jeffreysii, n. sp. (Plate XXIX. figs. 51–55.)

Atlantic type? Distribution: *Recent*—Great Britain and Ireland. *Fossil*—Raised beaches, Scotland.

Carapace, as seen from the side, ovate, highest near the front; surrounded by a well-developed fillet or flange; height equal to more than half the length. The anterior margin is wide, well-rounded, and bordered by a flattened lamina which is marked with transverse hair-like lines. Posterior extremity narrowed and produced below into a spinous plate. Dorsal margin highest over the anterior hinge-joint, where it bears a conspicuous polished tubercle; ventral margin nearly straight. Seen from above, the outline is tumid, oblong, with nearly parallel sides, and tapering suddenly to the broadly keeled extremities; the anterior hinge-tubercles very conspicuous. End view tumid, broadly rounded below, narrowed above. Surface smooth and polished, marked with a reticulated moniliform pattern, which is composed of rows of numerous small tubercles (fig. 55). Animal unknown.

Length $\frac{1}{40}$ in., height $\frac{1}{70}$ in.

Hab. Deep water, very rare. Channel Islands (*Mr. Jeffreys's dredgings*); Roundstone, in shell-sand (*Dr. Alcock*).

A form described by me in the 'Transactions of the Zoological Society' (vol. v. p. 374) under the name *Cythere catenata* is closely similar to the present in its surface-markings; and I have since learnt that it is only the young of *C. echinata*, Sars, a species till recently quite unknown to me, its catenate tubercles being developed in later life into spines. It is possible that *C. Jeffreysii* may in like manner prove to be an imperfectly developed form of some strongly spinous species; but it has every appearance of mature growth, and the specimens from both the above-named localities are in every respect similar.

23. Cythere laticarina, n. sp. (Plate XXXI. figs. 1–4.)

British type? Distribution: *Recent*—Great Britain. *Fossil*—Raised beaches, Scotland.

Carapace, as seen from the side, subtriangular, highest in front; length to height as five to three. Anterior margin broad, rather suddenly rounded below, more gradually above, bordered below by a row of short spines; posterior margin rather angular. Dorsum highest over the anterior hinge, whence it slopes gently and almost in a right line backwards. Ventral margin nearly straight. The outline, as seen from above, is oblong

oval, with parallel sides and abruptly tapering obtuse extremities; over the anterior hinge are two conspicuous polished tubercles, supported on divergent processes or ribs. The whole carapace is surrounded by a fillet, which, on the anterior and ventral aspects, forms a very broad and stout keel. End view ovate, tumid, very broad below. The surface of the shell is marked with rather large, vaguely defined pits, and is slightly scabrous. Animal unknown.

Length $\frac{1}{37}$ in., height $\frac{1}{62}$ in.

Hab. Channel Isles, 15–30 fathoms (*Mr. J. G. Jeffreys*); Oban (*Mr. D. Robertson*).

This is strikingly similar in general contour to *C. Jeffreysii*; but in other respects the two species are abundantly distinct. It bears also some resemblance to *C. marginata* (Norman) and to certain forms of *C. tuberculata*. From the last-mentioned it may be at once separated by the conspicuous stalked tubercles of the anterior hinge, the absence of tubercles on the lateral surfaces of the valves, and, as seen from above, by the regularly oval contour, without posterior tumidity. From *C. marginata* the hinge-tubercles, characters of surface, and want of excessive angularity of the dorsum sufficiently distinguish it.

24. CYTHERE MARGINATA, Norman. (Plate XXXI. figs. 5–8.)

Cythere marginata, Norman, Ann. & Mag. Nat. Hist. vol. ix. (1862) p. 47, pl. iii. figs. 10–12.

Carapace subquadrangular, highest in front; height equal to more than half the length. Anterior margin rounded below, sloping steeply backwards above, and forming at its dorsal extremity a conspicuous angular elevation over the anterior hinge. Inferior margin nearly straight; dorsal margin sloping sinuously and rather steeply backwards. Posterior extremity narrowed, angular, produced below. Outline, as seen from above, oblong, widest in the middle and tapering abruptly at each extremity; width equal to half the length. End view tumid, ovate. Surface covered with large angular pittings, which are separated from each other by narrow ribs. Animal unknown.

Length $\frac{1}{37}$ in., height $\frac{1}{65}$ in.

Hab. Lamlash Bay (*Rev. A. M. Norman*).

The single specimen upon which this species is founded is scarcely well enough marked in its characters to form a satisfactory species; but I am unable to refer it with certainty to any other described form.

25. CYTHERE QUADRIDENTATA, Baird. (Plate XXXI. figs. 19–30.)

Cythere quadridentata, Baird, Brit. Entom. p. 173, t. xxi. fig. 2.

British type. DISTRIBUTION: *Recent*—Great Britain, Ireland, Bay of Biscay. *Fossil*—Glacial, Scotland.

Carapace, as seen from the side, oblong quadrangular or cuneate, highest in front; height equal to about one-half the length. Anterior border obliquely rounded, often bearing a row of from eight to twelve small teeth. Posterior margin narrowed, angular, excavated above and considerably produced below, where it is generally armed with about four sharp spines. The inferior margin is straight or slightly convex, the superior elevated over the anterior hinge, thence sloping sinuously backwards. The

outline, as seen from above, is oblong ovate or hastate, the junction of the hinge-margins marked behind the middle by a deep, sharply defined sulcus. Ventral surface sulcate along the whole length of the contact-margins, which are bordered by a broad, well-defined, smooth band. End view ovate. The surface of the shell is marked with oblong punctures, which are arranged chiefly in longitudinal rows, but in curved lines round the anterior border. The valves, in typical specimens, are swollen behind, forming an abrupt angular elevation, from which a longitudinal rib runs directly forwards, and two others in an oblique direction towards the upper and lower margins of the valve; the left valve is considerably smaller than the right. Animal unknown.

Length $\frac{1}{33}$ in.

Hab. In deep water, rare. Coasts of Northumberland and Durham, 25–46 fathoms (*G. S. B.*); Ormeshead and Oban (*Mr. D. Robertson*); Shetland (*Rev. A. M. Norman*); Hebrides and the Minch (*Mr. J. G. Jeffreys*).

The specimen represented in figs. 19–22 is the form originally described by Dr. Baird under the specific name *quadridentata*; that shown in fig. 25 is a very similar form, while fig. 23 differs only in being less angular and the surface-markings fainter. The specimens from which figs. 26–30 were drawn appear to be merely a variety, or perhaps the adult or the female of the same species. The peculiar characters of the ventral and dorsal surfaces, as well as the elongated punctation, are distinctly retained. The species is a rare one, and I have had no opportunity of thoroughly examining the animal.

26. Cythere emaciata, Brady. (Plate XXXI. figs. 31–37.)

Cythere emaciata, Brady, Brit. Assoc. Report, 1866, p. 210.

Atlantic type. Distribution: *Recent*—Great Britain and Ireland. *Fossil*—Raised beaches, Scotland.

Carapace, as seen from the side, compressed, quadrangular, higher in front than behind; length equal to more than twice the height. Anterior extremity flattened or but slightly rounded, often fringed with a row of eight or nine teeth. Posterior extremity narrowed, excavated above, produced and toothed below. Dorsal and ventral margins nearly straight. Outline, as seen from above, oblong, widest behind, nearly thrice as long as broad; the ventral keel produced behind into two broad fimbriated processes. The contact-margins on the ventral surface are bordered by two flattened ridges, forming a very broad keel, which projects considerably behind. End view oval, with rounded lateral protuberances. Surface marked with large pits arranged longitudinally; in small or young specimens the punctures are oblong, as in the preceding species; along the middle of the valve runs a conspicuous elevated rib, a less distinct ridge within the ventral margin, and another smaller one in an oblique direction behind the antero-dorsal angle. Right valve larger than the left. Animal unknown.

Length $\frac{1}{40}$ to $\frac{1}{30}$ in., height $\frac{1}{90}$ to $\frac{1}{80}$ in.

Hab. In deep water. Shetland (*Rev. A. M. Norman*); Peterhead and Ormeshead (*Mr. D. Robertson*); Hebrides (*Mr. J. G. Jeffreys*); Aberdeenshire coast (*Mr. Dawson*); Northumberland and Durham coasts, 35 fathoms, and Birterbuy Bay, 15 fathoms (*G. S. B.*); Devonshire coast, 60 fathoms (*Mr. Spence Bate*); in shell-sand from Roundstone (*Dr. Alcock*), Baltimore (*Mr. E. C. Davison*), and Galway Bay (*Prof. Rowney*).

This species bears considerable resemblance to Prof. T. R. Jones's figures of *C. retifastigiata*, but a reference to the type specimens, kindly placed at my disposal by that author, convinces me that the two species are quite distinct. The more elongated forms figured at 31 and 36 are very probably, as in other species, the males; but I have not been able to satisfy myself of this, all the specimens which I have examined having proved to be only empty shells.

27. CYTHERE MIRABILIS, nov. sp. (Plate XXIX. figs. 7, 8.)

DISTRIBUTION: *Recent*—Scotland. *Fossil*—Glacial, Scotland.

Valves, as seen from the side, subtrapezoidal, highest at the anterior third; greatest height equal to two-thirds of the length. Anterior extremity broadly and obliquely rounded, its lower half bearing a series of short blunt teeth; posterior narrow, very slightly curved, bearing four teeth at the lower angle; superior margin sloping steeply and in a convex line from before backwards, terminating abruptly in an obtuse angle at each extremity, more or less abruptly undulated or emarginate throughout, but especially behind the anterior extremity, where it is twice or thrice deeply and irregularly jagged; inferior margin evenly convex. Outline, as seen from above, ovate, twice as long as broad, obtusely toothed and mucronate behind, margins irregularly spinous and emarginate. Hinge-joint very strongly developed, consisting in the right valve of a triangular tooth in front and an obliquely truncate one behind; in the left of a strong central bar ending abruptly behind, and elevated into an angular tooth in front. Surface of the shell covered in its central and middorsal portions with large angular excavations, and surrounded on the ventral margin and the extremities by wide and sharply cut irregularly concentric furrows, across which the separating ribs anastomose sparingly.

Length $\frac{1}{27}$ in.

Hab. Off Lumpan Head, Lewis (*Admiralty soundings*).

I have seen only one valve of this species in a recent state; some of the details above given are taken from fossil specimens obtained from the Scotch Glacial clays.

28. CYTHERE MUCRONATA (G. O. Sars). (Plate XXVI. figs. 34, 34 *a*.)

Cythereis mucronata, G. O. Sars, *loc. cit.* p. 48.

—— *spinosissima*, Brady, Trans. Zool. Soc. vol. v. p. 386, pl. lx. figs. 10*a–e*.

Scandinavian type. DISTRIBUTION: *Recent*—Norway, Shetland.

Valves, as seen from the side, subquadrangular, highest in front of the middle; greatest height equal to half the length. Anterior margin rounded, fringed with six very broad, strong, linguiform, obtusely rounded spines; posterior narrower, fringed also with a series of about nine much smaller and abruptly truncated spines; superior margin arched, irregularly emarginate, inferior nearly straight. The central portion of the valves is closely beset with large, clumsy, irregularly angular protuberances, which, towards the extremities, are much fewer and smaller; along the ventral margin they form a row of stout tooth-like spines, the last of which projects strongly outwards and backwards.

Outline, as seen from below, rhomboidal; greatest width behind the middle, where the last ventral spine projects, forming a strongly marked angle.

Length $\frac{1}{23}$ in.

Hab. Shetland (*Rev. A. M. Norman*).

One valve only, found amongst dredged sand.

29. CYTHERE DUNELMENSIS (Norman). (Plate XXX. figs. 1–12.)

Cythereis dunelmensis, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 22, pl. vii. figs. 1–4.

—— *horrida*, Sars, *loc. cit.* p. 45.

Scandinavian type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Great Britain. *Fossil*—Glacial clays and raised beaches, Scotland and Ireland.

Carapace of *female*, as seen from the side, elongate quadrangular, highest in front; greatest height equal to nearly two-thirds of the length. Anterior margin broadly rounded and irregularly fringed with short, blunt spines; posterior rectangularly truncate. Dorsal and ventral margins nearly straight. Outline, as seen from above, subovate, widest in front of the middle, sides nearly parallel; width equal to about half the length. End view subquadrangular, widest in the middle. Surface coarsely reticulated and excessively rough, with spinous and tubercular elevations; a curved spinous ridge just within the anterior margin, and a more or less conspicuous tubercle in front of the centre of the valve. The posterior portion of the ventral margin is armed with a series of irregular squamous spines, which often coalesce so as to form a rugged, dentate lamina. The shell of the *male* (figs. 5–8) is much elongated, height equal to twice the length; ventral margin distinctly sinuated, and the surface-spines much coarser and stronger. Colour yellowish. "Eyes large and located in the tubercles of the carapace. Upper antennæ distinctly six-jointed; last joint almost equal in length to the two preceding, terminating in four equal setæ. Second joint of the last foot longer than the two following, and bearing on the anterior margin a group of four hairs; terminal claw very long and slender. Basal portion of the male copulative organs subquadrangular, apical portion subtriangular, produced and obtusely acuminate in front."

Length $\frac{1}{30}$ in., height $\frac{1}{50}$ in.

Hab. Durham coast, in 40 fathoms (*Rev. A. M. Norman*); off Scarborough (*Mr. Leckenby*); Cumbrae, 10 fathoms (*Mr. D. Robertson*); Croulin Islands (*Mr. J. G. Jeffreys*); Roundstone (*Dr. Alcock*).

This species occurs with tolerable frequency in the Scotch Glacial clays; but, in the living state, appears to be somewhat rare. In the Frith of Clyde and north-western Scottish coast it is rather more common than on the eastern coast. It seems also to be moderately common on the coast of Norway.

30. CYTHERE WHITEII, (Baird). (Plate XXX. figs. 21–24.)

Cythereis Whitei, Baird, Brit. Entom. p. 175, t. xx. figs. 3, 3 *a*.

British type. DISTRIBUTION: *Recent*—Great Britain, Levant. *Fossil*—Glacial, Ireland.

Valves, as seen from the side, elongated quadrangular; length equal to twice the height. Anterior margin abruptly rounded below, and sloping steeply backwards above, where it

terminates in a conspicuous elevation over the anterior hinge; posterior margin straight, and much emarginate. The dorsal margin slopes pretty evenly backwards from the anterior hinge; the ventral margin nearly straight, but bearing a variable number of regularly set, short, blunt teeth. Outline, as seen from above, somewhat cuneate, suddenly narrowed behind, broadest at the posterior third; width equal to nearly half the length. End view subquadrangular. The surface of the shell is rugose, and bears three rows of elevated processes, or truncated spines; one row commences at the anterior hinge, running parallel to and within the anterior and ventral margins nearly as far as the posterior extremity; a second row runs directly backwards, almost in the median line of the valve; a third and much less conspicuous row runs transversely, parallel to and just within the posterior margin. Animal unknown.

Length $\frac{1}{35}$ in., height $\frac{1}{70}$ in.

Hab. "In shell-sand from Tenby, *Prof. T. Rupert Jones*; and from Torquay, *W. C. Williamson, Esq.*" (*Dr. Baird*); Campbeltown, 10 fathoms (*Mr. D. Robertson*).

31. CYTHERE ANTIQUATA (Baird). (Plate XXX. figs. 17–20.)

Cythereis antiquata, Baird, Brit. Entom. p. 176, tab. xx. fig. 2.

British type. DISTRIBUTION: *Recent*—Great Britain, Ireland, Bay of Biscay, Levant. *Fossil*—Glacial clay and raised beaches, England, Scotland, and Ireland.

Valves rectangular, quadrilateral; length equal to twice the height. Anterior border rounded at the angles, and armed below with a series of blunt spines; posterior margin rectangularly truncate, and bearing below the middle several strong linguiform spines. Dorsal and ventral margins parallel, the latter quite straight, the former cleft into three or four segments with intervening sulci. The carapace, as seen from below, is oblong, with projecting lateral alæ, which taper towards the front, but terminate abruptly behind, giving to the whole a somewhat arrow-headed outline. Seen from above, the outline is more irregular. End view subtriangular, deeply emarginate below, each lateral portion with two strongly projecting ridges. The surface of the shell is tuberculate, and bears two conspicuous, sharply defined longitudinal ridges, which terminate abruptly in angular elevations near the posterior extremity of the valve. These ribs are mostly perforated at the base, the rows of apertures thus produced being very conspicuous on the ventral aspect of the shell (fig. 19). The anterior hinge-tubercle is very large and conspicuous. Left valve larger than the right. Upper antennæ five-jointed, last joint long and slender; second joint equal in length to the following two; spines straight, very long and slender. Second joint of lower antennæ very short, scarcely half the length of the third joint. Second joint of the last foot equal in length to the following two; terminal claw very long and slender. Abdominal lobes terminating in a short seta.

Length $\frac{1}{25}$ in., height $\frac{1}{50}$ in.

Hab. In depths of 7 to 60 fathoms. Hebrides and the Minch (*Mr. J. G. Jeffreys*); Tobermory, at roots of *Laminaria*; Shetland, Isle of Skye, and Plymouth (*Rev. A. M. Norman*); Aberdeenshire coast (*Mr. Dawson*); Oban, Ormeshead, Cumbrae, and Campbeltown, dredged (*Mr. D. Robertson*); Birterbuy Bay, dredged, and in oyster-ooze from Stranraer (*G. S. B.*); in shell-sand from Tenby (*Prof. T. Rupert Jones*), Roundstone (*Dr. Alcock*), and Cowes (*Mr. E. C. Davison*); off Lewis, 18½ miles N.W., 59½ fathoms (*Admiralty soundings*).

The Frith of Clyde seems to be peculiarly rich in the spinous forms hitherto referred to the genus *Cythereis*, Mr. Robertson having there dredged all the British species in a living state: *Cythere antiquata* appears to be the commonest and most widely distributed of these, but is nowhere very abundant. It is not mentioned by Sars among the Norwegian Ostracoda.

32. Cythere Jonesii (Baird). (Plate XXX. figs. 13–16.)

Cythereis Jonesii, Baird, Brit. Entom. p. 175, tab. xx. fig. 1; Norman, Nat. Hist. Trans. Northumberland and Durham, vol. i. p. 21, pl. vii. figs. 5–8.

—— *fimbriata*, Norman, Ann. & Mag. Nat. Hist. Jan. 1862, pl. iii. fig. 9.

Cythere ceratoptera, Bosquet, Entom. fossil. des terr. tertiair. de la France, p. 114, pl. vi. fig. 2; Jones, Tertiary Entom. p. 39, pl. iv. fig. 1.

Cythereis spectabilis, Sars, *loc. cit.* p. 46.

—— *subcoronata*, Brady, Trans. Zool. Soc. vol. v. p. 384, pl. lx. figs. 9*a–e*, and (?) Speyer, Ostrac. der Casseler Tertiärbild. p. 38, tab. iv. figs. 9, 10.

? *Cythereis cornuta*, Jones (young), Entom. of Tert. Form. Eng. p. 39, pl. iv. fig. 19.

Atlantic type. Distribution: *Recent*—Norway, Great Britain; (var. *ceratoptera*) Ireland; Bay of Biscay, Levant. *Fossil*—Glacial, Scotland; (var. *ceratoptera*) tertiary, France, Belgium, England.

Valves compressed in front, but gradually swelling towards the hinder extremity; as seen from the side, oblong, subquadrangular or ear-shaped; height equal to much more than half the length. Anterior margin rounded, spinous below, and terminating above in a well-marked angular elevation over the anterior hinge. Posterior extremity irregularly bordered with spines, the strongest of which are at the ventral angle. Ventral margin gently curved; dorsal much shorter than the ventral, straight but emarginate, and forming an elevated ridge, which bears at its posterior extremity three or four strong, linguiform processes. The outline, as seen from below, is irregularly lozenge-shaped or subrhomboidal, and bordered with strong spinous projections, which gradually increase in size from the front to the posterior third, where they terminate abruptly; width equal to two-thirds of the length. End view equilaterally triangular, the base perfectly straight. The surface of the shell is quite smooth, and rises gradually from the front to near the posterior extremity of the valve, at which point the elevation terminates abruptly in a jagged and spinous declivity. A strongly developed ridge commences at the anterior hinge-tubercle, running a little within and parallel to the anterior and ventral margins, as far as the transverse declivity just described; this ridge is, in the first portion of its course, smooth and rounded, but at the antero-ventral angle becomes spinous, and retains that character to its termination: the spines, or "linguiform processes," are about ten in number, very large and strong, with rounded extremities. Colour ochreous. Eye-tubercles very large and prominent. Antennæ elongate, almost exactly similar to those of *C. dunelmensis*. Feet slender; second joint of the last pair shorter than the united lengths of the following two. Apical portion of the male copulative organs forming an elongated acuminate process.

Length $\frac{1}{25}$ in., height $\frac{1}{45}$ in.

Hab. In depths of from 2 to 60 fathoms. Orkney (*Mr. C. W. Peach*); Hebrides and the Minch, 45-60 fathoms (*Mr. J. G. Jeffreys*); Tobermory at roots of *Laminaria*, Shetland, Isle of Skye and Lamlash Bay, and Dogger bank (*Rev. A. M. Norman*); Aberdeenshire coast (*Mr. Dawson*); Oban, Cumbrae, Ormeshead, Bute, and Campbeltown (*Mr. D. Robertson*); Northumberland coast (*G. S. B.*); in shell-sand from Roundstone (*Dr. Alcock*); off Lewis (N.B.), 59½ fathoms (*Admiralty dredgings*) *.

33. Cythere (?) acerosa, n. sp. (Plate XXXI. figs. 55–58.)

Carapace, as seen from the side, reniform, highest in the middle, greatest height equal to half the length. Anterior extremity flattened, subtruncate, obtusely angular at its junction with the dorsal margin; posterior rounded. Superior margin arched, highest in the middle; inferior deeply concave, nearly parallel with the dorsal margin. The anterior, posterior, and postero-ventral portions of the margin are excessively compressed and laminar. Outline, as seen from above, oblong, hexagonal; extremities suddenly tapered, sharply acuminate, sides parallel; width equal to one-fourth of the length. Surface smooth; colour yellowish, opaque. Animal unknown.

Length $\frac{1}{42}$ in.

Hab. Plymouth (*Rev. A. M. Norman*).

This remarkable species ought very probably to form the type of a distinct genus; but as I have had no opportunity of examining the animal, it seems best *pro tempore* to place it in its present position. The only specimen extant is in the collection of the Rev. A. M. Norman, and was obtained by the late Mr. Barlee from nets of trawlers at Plymouth.

Genus 2. Limnicythere, Brady †.

Shell irregularly tuberculate or spinous, rather thin, and horny in texture. Animal like that of *Cythere*, except that the antennæ are armed with short setæ instead of spines. Upper antennæ five-jointed, slender, the last joint much elongated, the antepenultimate excessively short. Postabdomen terminating in two rather stout setæ. Inhabits fresh water.

Of this genus I have not yet seen the males; but the structure of the upper antennæ, together with the external characters of the carapace and the freshwater habitat, seems to require that it should be placed in a distinct genus. I think it very probable that a more minute examination than I have yet been able to make may reveal also other differences than those here specified.

1. Limnicythere inopinata (Baird). (Plate XXIX. figs. 15–18, Plate XXXVIII. fig. 9, and Plate XXXIX. fig. 1.)

Cythere inopinata, Baird, Brit. Entom. p. 172, tab. xx. figs. 1, 1 *a–e*.

Valves, as seen from the side, reniform, irregular, tuberculate, highest in the middle; greatest height equal to more than half the length. Anterior border rather narrower than the posterior, rounded, and produced into a flattened encircling flange. Posterior

* See Appendix.

† Intellectual Observer, vol. xii. p. 121.

margin slightly rounded, and armed below with a series of from six to twelve small spines. The dorsum forms a flattened arch; ventral margin deeply incurved near the middle. Seen from above, the outline is irregularly lanceolate, sharply mucronate in front, obtusely behind, and mostly asymmetrical, on account of a want of correspondence in the tuberculation of the valves; greatest width situated at the posterior third, equal to less than half the length. End view somewhat pyramidal, strongly keeled below. The surface of the valves is punctate, and marked near the middle with a deep transverse furrow; the anterior half of each valve bears mostly one, the posterior half two tubercles; but these are subject to much variation in position and number, scarcely any two shells being precisely alike. Colour dull white or straw-coloured. Upper antennæ slender, five-jointed; last joint linear, equal in length to the preceding; the third scarcely more than half the length of either of the two following; second equal to third and fourth united. Terminal claws three, nearly equal in length, curved and setiform; the fourth joint bears at its apex four setæ, about equal in length and strength to the terminal claws, and near the middle two shorter setæ. The second and third joints bear each one seta. Terminal claws of the second antennæ slender. Feet short and stout; terminal claws of the first and second pairs stout and strongly curved; those of the third pair slender, subsetiform, and equal in length to the three preceding joints; second joint equal in length to the two following. Males unknown.

Length $\frac{1}{40}$ in., height $\frac{1}{80}$ in.

Hab. In fresh water. Hardwick Lake and Raby Park, county Durham (*Rev. A. M. Norman*); Fulwell Cemetery, Gibside, and in a mill-stream at Hedworth, county Durham; East Belsay Lake, Northumberland, and North Shaws Loch, Selkirkshire (*G. S. B.*); in a pond between Hanwell and Southall, Middlesex (*Dr. Baird*); Glasgow and Paisley Canal (*Mr. D. Robertson*).

2. Limnicythere monstrifica (Norman). (Plate XXIX. figs. 9–12.)

Cypris monstrifica, Norman, Ann. & Mag. Nat. Hist. vol. ix. 1862, p. 45, pl. iii. figs. 4, 5.

Valves, as seen from the side, oblong subquadrangular, strongly spinous and tuberculate. Extremities boldly rounded, the anterior bearing on eaeh valve a marginal row of about twelve sharp spines. Dorsal margin straight, angulated at its anterior extremity, whence it slopes gently downwards and backwards. Ventral margin incurved centrally. Seen from above, the outline is compressed, oval, each valve bearing two very large spinous tubercles, and several smaller spines and ridges. End view subquadrate, irregularly angulated. The valves are closely punctate, furrowed across the middle; one strong spinous tubercle on the anterior half, and two on the posterior half of each valve. The posterior portion is also beset with numerous small sharp spines. Animal unknown.

Length $\frac{1}{33}$ in.

Hab. Fresh water. In the canal at Fleckney, Leicestershire, August 1856 (*Rev. A. M. Norman*).

This species was described by Mr. Norman as a *Cypris*. It seems, however, to have more affinity with the genus *Limnicythere*, to which I here refer it. Mr. Norman observes that it made no attempt to swim in the few days during which he kept it alive.

The excessively rugged surface of the shell would, indeed, constitute a serious impediment to any rapid movement through the water; consequently we do not observe any such condition of carapace in the genus *Cypris*, nor even in *Candona*. The two or three specimens on which the species was originally founded are all that have as yet been observed. It may be noted that specimens of *Cypris gibba* sometimes assume a tuberculated or spinous surface; but never, so far as I know, to such an extent as in the present species.

Genus 3. Cytheridea, Bosquet.

Shell, as seen from the side, subtriangular or triangularly ovate, highest at the anterior third; thick and compact in structure. Surface more or less pitted, sometimes smooth and papillose, or concentrically rugose. Hinge-margin of the right valve bearing a series of small tubercles or crenulations, which are received into corresponding depressions of the opposite (left) valve; these tubercles are mostly disposed in two terminal groups, the intervening portion of the valve-margin being plain or marked by minute tubercles on the *left*, and corresponding fossæ on the *right* valve. Lucid spots about four, in a transverse row, near the centre of the valve, and two detached spots (which sometimes coalesce) in front of the main group. Upper antennæ very robust, mostly five-jointed, and bearing strong spines; the last joint narrow and elongated; lower antennæ four-jointed; urticating setæ long and slender, biarticulate. Mandibles large and numerously toothed; palp three-jointed, and bearing a distinct branchial appendage. The right foot of the first and second pairs in the male different from the rest, that of the first pair very strong and prehensile; of the second very feeble, the apical portion rudimentary and destitute of a terminal claw. Eyes distinct.

I am unable to find any good distinctive characters to separate the genus *Cyprideis* (Jones) from *Cytheridea*. G. O. Sars restricts the latter genus (apparently) to certain very broad and dentate forms, which, however, do not appear to me to present any well-marked generic characters: the animal is not known, but may be supposed to be, in all probability, not far different from that of the typical *Cytheridea* (*Cyprideis*, Sars). It may be noted that some of the species included by Sars under *Cyprideis* belong distinctly to the series included by Bosquet in his *Cytheridea*; and one of them (*Cyprideis Bairdii*, Sars) is, as I believe, identical with *Cytheridea papillosa*, Bosquet. If the distinctness of the two genera be maintained, the name *Cyprideis* should, I think, be reserved exclusively for *C. torosa*, which differs to some extent in its anatomy, and probably also in its mode of reproduction. Many of the fossil forms described by authors as *Bairdiæ* belong undoubtedly to *Cytheridea*. The genus is a small one; bnt some of the species, though local, occur in prodigious quantities when the conditions of existence are favourable.

1. Cytheridea elongata, Brady. (Plate XXVIII. figs. 13–16, and Plate XL. fig. 6.)

Cythere angustata, Baird, Brit. Entom. p. 172, tab. xxi. fig. 6.

Atlantic type. Distribution: *Recent*—Great Britain, Ireland, Bay of Biscay. *Fossil*—Glacial deposits and raised beaches, Scotland and Ireland.

Carapace, as seen from the side, elongate, not much higher behind than in front;

greatest height in the middle, and equal to considerably less than half the length, evenly rounded in front, obliquely rounded behind, and obsoletely angular at the infero-posterior angle. Superior margin evenly and gently arched, inferior nearly straight for the anterior two-thirds, then gently convex, behind which it is slightly upturned. Outline, as seen from above, subovate, sides nearly parallel, width equal to much less than half the length; anterior extremity obtusely pointed, posterior broadly rounded and emarginate in the middle. End view nearly circular, keeled below. Shell smooth, ornamented with very small and distant circular papillæ, the ventral surface faintly grooved in a longitudinal direction, these grooves sometimes extending obscurely round the anterior margin. Colour light purplish brown; of specimens from shell-sand horny yellow. Hinge formed by a median crest of the right valve and two terminal curved flanges of the left valve; altogether weakly developed, and showing no trace of crenulation, but an obscure tooth-like projection on the anterior flange of the left valve. Penultimate joint of the upper antennæ nearly twice as long; second joint nearly four times as long as the third; last joint half as long as the preceding; basal joint very stout, and bearing on its inferior margin a row of about twelve short spinous hairs. Terminal claw of the third pair of feet long, slender, and flexuous; a single short seta at the apex of the penultimate joint, none on the antepenultimate. First pair of feet in the *male* alike on both sides, subprehensile; last joint bearing one strong, slightly curved terminal claw, and one very short spine; second joint armed with one apical claw, similar in size and shape to that of the last joint; second pair alike on both sides (?), basal joint bearing a stout apical spine; terminal claw long, setiform.

Length $\frac{1}{28}$ in.

Hab. In deep water. Aberdeenshire coast (*Mr. Dawson*); the Minch and Channel Islands (*Mr. J. G. Jeffreys*); Devonshire coast (*Mr. C. Spence Bate*); Exmouth, Burrow Island, Isle of Portland, Swansea, Tenby, Tobermory, Youghal (*Rev. A. M. Norman*); Pegwell Bay and Poole Bay (*Prof. T. Rupert Jones*); in shell-sand from the Mumbles, Frith of Forth, Thames and Roundstone, and in tide-pools at Sunderland* (*G. S. B.*); off Yarmouth (*Mr. D. O. Drewett*); "Devonshire, *W. C. Williamson, Esq.*; Tenby, *T. Rupert Jones, Esq.*" (*Dr. Baird*); off Ormeshead (*Mr. D. Robertson.*)

Of *C. elongata* I have seen only one specimen containing the animal—a male. This was found at the roots of *Laminaria* at Tobermory by the Rev. A. M. Norman. In some respects this differs rather remarkably from others of the genus, as, for instance, in the conformation of the first and second feet, which are here alike on both sides. The want of crenulation in the hinge-margins of the valves is also an important distinction; and notwithstanding the general resemblance of the species to the genus *Cytheridea*, I cannot help suspecting that a fuller investigation of the structure of the animal may show valid generic differences.

Dr. Baird has doubtfully referred this species to *Cytherina angustata*, Münster; but the differences in shape and in proportions of length and breadth appear to me too serious to allow of this identification. It approaches more closely to "*Bairdia*" *lithodomoides*, Bosquet; but is not precisely similar to it, as I have satisfied myself by the examination of specimens sent to me by that author.

* This was in all probability a washed-up specimen, as the valves were empty.

2. Cytheridea papillosa, Bosquet. (Plate XXVIII. figs. 1–6, and Plate XL. fig. 1.)

Cytheridea papillosa, Bosquet, Entom. fossil. des terr. tertiair. de la France, p. 42, pl. ii. figs. 5 *a*, *b*, *c*, *d*.
Cythere Bradii, Norman, Brit. Assoc. Report, 1864, p. 192.
—— *debilis*, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 15, pl. v. figs. 5–8, and note, p. 28.
Cyprideis Bairdii, G. O. Sars, *loc. cit.* p. 52.

Scandinavian type. Distribution: *Recent*—Baffin's Bay, Norway, Great Britain. *Fossil*—Glacial deposits and raised beaches, Scotland and Norway; tertiary, France and Belgium.

Valves of the *female*, as seen from the side, oblong, slightly higher in front than behind, height equal to more than half the length; the postero-ventral termination somewhat angular. Anterior margin obliquely rounded; posterior sloping steeply with a gentle curve from above downwards, terminating below in an obtusely rounded angle. Superior margin very slightly arched, inferior straight or indistinctly sinuated in front of the middle. Outline, as seen from above, ovate, tumid, rounded at the extremities, the anterior of which is the narrowest; greatest width behind the middle, equal to half the length; a slight longitudinal depression along the junction of the two valves behind the middle. End view nearly circular. The shell of the *male* is much more elongated, and nearly equal in height throughout, the height much less than half the length; inferior margin more decidedly sinuated. Surface of the shell smooth and shining, cream-coloured, clouded with reddish brown on the dorsal aspect; beset with distant circular papillæ. Lucid spots arranged in a transverse row of four, with two others at a considerable distance in front. Terminal hinge-processes distinctly crenulated, the intervening portion more slightly so (Plate XXVIII. figs. 5 *a*, *b*). Terminal joint of the upper antenna very short, not half the length of the preceding, armed with a long spine and two setæ. Spines of the third and fourth joints very robust, ensiform. Branchial appendage of the mandibular palp bearing three setæ. First pair of feet very short, last two joints imperfectly separated; terminal claw of the third foot much longer than the second joint and finely ciliated on the margins. Right foot of the first pair in the *male* very strong, subcheliform, the last three joints coalescent, very thick and massive, and bearing on the anterior margin a very stout, bearded linguiform process; terminal claw very strong and bent almost at a right angle; "right foot of second pair very rudimentary, the terminal portion composed of one very small ovate joint, bearing a short seta on the anterior margin;", the left also different from that of the female, subprehensile, the last three joints thickened; terminal claw strong and doubly pectinate. Basal portion of the male copulative organs subovate; terminal portion bipartite, the anterior segment small and obtusely triangular, the posterior larger and produced into an acuminate process.

Length $\frac{1}{30}$ in., height $\frac{1}{60}$ in.

Hab. In deep water, 10 to 50 fathoms. Hebrides, the Minch (*Mr. J. G. Jeffreys*); Bute, Loch Fyne and Cumbrae, and Ormeshead (*Mr. D. Robertson*); Aberdeenshire (*Mr. Dawson*); Northumberland and Durham coasts (*G. S. B.*); Yorkshire coast, off Scarborough (*Mr. Leckenby*); Thames estuary (*Mr. E. C. Davison*).

C. papillosa seems to be a strictly northern species, and on the Scotch coasts and those of the north-east of England is one of the most abundant forms. In some few favourable localities, especially in Loch Fyne, it occurs in great profusion, and is associated with

C. punctillata to the exclusion of almost all other species. It is remarkable that Sars has found these two species associated in a similar manner on the Norwegian coast. From fossil specimens communicated to me by M. Bosquet, I cannot entertain much doubt that the present species is identical with the *C. papillosa* of that author, though the recent specimens are uniformly larger than the fossil ones.

3. CYTHERIDEA PUNCTILLATA, Brady. (Plate XXVI. figs. 35–38, Plate XXVIII. figs. 17–20.)

Cytheridea punctillata, Brady, Ann. & Mag. Nat. Hist. vol. xvi. (1865) p. 189, pl. ix. figs. 9–11.
Cyprideis proxima, G. O. Sars, *loc. cit.* p. 54.

Scandinavian type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Britain. *Fossil*—Glacial and post-tertiary deposits, England, Scotland, and Norway.

Carapace of the *female*, as seen from the side, oblong, subovate or subtriangular, often marked more or less distinctly with a central transverse sulcus; greatest height equal to more than half the length, situated at the anterior third. Anterior margin broad and well rounded; posterior narrower, suddenly round or almost angular below, but not so much so as in the preceding species. Superior margin gently arched, highest a little in front of the middle; ventral nearly straight. Outline, as seen from above, oval, with rather obtuse extremities. End view ovate, narrowed above, broadly rounded below. The shell of the *male* is more elongated, and presents differences of proportion much the same as in *C. papillosa*. Surface rough and quite free from polish, marked with thickly set rounded pittings, in the intervals of which are scattered elevated papillæ. Lucid spots six or eight, four in the line of the central sulcus; the rest in one or two separate patches in advance of the main group. Substance of the shell very dense and thick. Colour dull brown. Superior antenna rather slender, last joint bearing three terminal setæ. Distal portion of the first feet more slender than in the preceding species, distinctly three-jointed. Terminal claw of the last pair of feet very long and almost straight, setiform. Distal portion of the right first foot of the male biarticulate, the first joint armed in front with a hooked spine, the last joint considerably swollen, its terminal claw short and curved; "right foot of the second pair as in *C. papillosa*, its terminal segment very small and composed of one joint, the left foot subprehensile, terminal claw bipectinate. Basal portion of the copulative organs of the male very large, subquadrangular, broader than long; terminal portion short, bearing two processes, of which the anterior is obtuse, the posterior acuminate."

Length $\frac{1}{33}$ in., height $\frac{1}{60}$ in.

Hab. In deep water, 10–60 fathoms. Suffolk coast, dredged by Mr. D. O. Drewett; Loch Fyne (*Mr. D. Robertson*); Shetland (*Rev. A. M. Norman*); Hebrides, the Minch (*Mr. J. G. Jeffreys*).

Cytheridea punctillata bears much resemblance in general form to *C. papillosa*. It is, however, a more robust species, higher in proportion to its length, and the postero-ventral angle much less angular. It is also further characterized by a well-marked and sometimes rather coarse surface-sculpture, and frequently by the central transverse sulcus, in these latter characters approaching closely *C. torosa*; whilst *C. papillosa* possesses, mostly, a smooth, papillose surface, without any trace of pitting, and *C. torosa*

a pitted surface, often without papillæ (both rules, however, being liable to occasional exceptions): in *C. punctillata* we see a mixture of these two characters.

Bairdia hebertiana, Bosquet, and *B. punctatella*, Bosquet, are both nearly allied to the present species, but not absolutely identical with it. M. Bosquet, to whom I have submitted specimens, agrees with me in this determination. Reuss's *Cytherina intermedia* comes, perhaps, still nearer; but his figures are insufficient for the purpose of identification. *Cytheridea Mülleri*, Bosquet, is also a very near relative, but is separated by the constant tendency to dentation of the anterior, and sometimes of the posterior margin; this character is *entirely* absent in *C. punctillata*.

The only British locality in which this species has been found abundantly is Loch Fyne, where, as previously stated, it occurs in great numbers in company with *C. papillosa*. It is by far the most abundant species in the Scotch glacial clays.

4. Cytheridea torosa (Jones). (Plate XXVIII. figs. 7–12, and Plate XXXIX. fig. 5.)

Candona torosa, Jones, Ann. & Mag. Nat. Hist. ser. 2, 1850, vi. p. 27, pl. 3. fig. 6.

Cyprideis torosa, Jones (in part), Tertiary Entom. of England, 1856, p. 21; Brady, Ann. & Mag. Nat. Hist. vol. xiii. (1864) p. 62, pl. iv. figs. 11–23, and Trans. Tyneside Nat. Field Club, vol. vi. p. 108, pl. iii. figs. 11–23; G. O. Sars, *loc. cit.* p. 51.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland, Levant, Sea of Azoff. *Fossil*—Posttertiary, England and Scotland.

Shell of the *female*, as seen from the side, oblong, subovate; length scarcely equal to twice the height. Dorsal margin arched, highest in front of the middle, where it is slightly gibbous. Ventral margin straight, or slightly incurved at the anterior third, mostly furnished with a single stout spine at the posterior angle. Extremities well rounded. The outline, as seen from above, is oblong-ovate (often irregularly and obsolately angular), sides nearly parallel, extremities obtusely pointed; the line of junction of the hinge-margins depressed behind the middle, forming a longitudinal sulcus. End view very broadly oval, nearly circular. The right valve is smaller than the left, and has the dorsal margin inclined more steeply, and almost in a right line, from before backwards. Shell of the *male* elongated, more than twice as long as high. Surface of the valves marked with closely set rounded pittings, and with a more or less conspicuous transverse sulcus somewhat in front of the centre. Young specimens are sometimes furnished also with a few short, thinly scattered hairs, and at the postero-inferior angle, near the spine before mentioned, there is often a conspicuous group of rather long hairs. Lucid spots arranged in a transverse row of about four near the sulcus, with two isolated and widely separated spots considerably in advance of the main group (fig. 11). The hinge-ment does not differ materially from that of the two preceding species (see fig. 12). Colour dull brown. Eyes distinct. The penultimate joint of the superior antenna scarcely longer than the preceding; the last joint rather longer and slender, ending in three setæ; spines long and slender. Terminal claws of the lower antennæ very long. Branchial appendage of the mandible-palp bearing five setæ (fig. 5*p*, Plate XXXIX.). Last three joints of the first foot about equal in length to the preceding one; second joint of the last foot much longer than the following two, and bearing at its apex one

long ringed seta and one shorter spine; terminal claw slender, about equal in length to the second joint. Right foot of the first pair in the *male* prehensile, four-jointed, much stronger than the left; the apex of the second joint giving origin to a long, curved, bearded seta; terminal claw moderately strong; basal joint of the right foot of the second pair bearing three plumose setæ (fig. 5*g*, Plate XXXIX.); second joint dilated at the distal extremity and bearing on the anterior margin two fasciculi of short setæ, and at the apex one very long ciliated seta; the left foot of the second pair scarcely different from that of the female. Second joint of the last pair on the right side armed on the anterior margin with a dense brush of setæ (fig. 5*h''*), on the left side with four semi-verticillate groups of shorter hairs. Abdomen of the female (fig. 5*m*) ending in a large, curved, acuminate process; postabdominal lobes bearing two very small plumose setæ. Copulative organs of the male divided at the apex into two processes, one of which is acutely lanceolate and serrated at the margin, the other obtusely rounded (fig. 5*k*); basal portion very large and subovate. The ova and undeveloped young are carried within the carapace of the female.

Length $\frac{1}{28}$ in., height $\frac{1}{50}$ in.

Hab. In brackish and occasionally in fresh water. Gravesend (*Prof. T. R. Jones*); Girdler Sand, Thames (*Mr. E. C. Davison*); Sedgefield, in fresh water; Hartlepool, Weston-super-Mare, and Guernsey (*Rev. A. M. Norman*); Belsay, in fresh water; Warkworth, Alnmouth, Camboise, Seaton Sluice, Jarrow Slake, and in shell-sand from Pegwell Bay (*G. S. B.*).

Cytheridea torosa was first found living by Prof. T. Rupert Jones in brackish water at Gravesend, and was by him referred to the genus *Candona*; further examination, however, showed the animal to be allied to, if not identical with, *Cythere*, and revealed also peculiarities of shell-structure for which the genus *Cyprideis* was proposed. But there seems to be no difference of generic importance between this species and the older genus *Cytheridea*. The peculiar setæ and ringed hairs which I have described as existing in *C. torosa* (Ann. & Mag. Nat. Hist. *loc. cit.*) are found in some, if not all, of the *Cytherideæ* and in some allied genera; and the characters of the first pair of feet in the male are analogous also to those met with in the foregoing species, though the right foot of the second pair is not rudimentary as in those species. For these reasons I have thought it desirable to class *C. torosa* as a true *Cytheridea*, though there remains one important character in which, so far as I know, this species stands alone amongst the Ostracoda, namely, the enormous number of ova borne at a single time by the female. How far this may prove to be of generic importance, future investigations must show; it is, at any rate, an interesting fact, and one which fully accounts for the immense numbers in which the species is often found.

I have had the opportunity, through the kindness of Professor T. Rupert Jones, of examining the specimens, both recent and fossil, from which the species was first described; and I find that the more strongly tuberculated forms, from which it derived its specific name, are referable to *C. lacustris*. Under these circumstances the name *lacustris* should, according to the laws of zoological nomenclature, give way to the prior term *torosa*, and the smoother species (the *torosa* of Sars, of the present monograph, and of my previous paper) be named afresh. But as the two specific designations here used

have already gained a certain currency, it seems best not to disturb the existing nomenclature for the sake of adherence to a law which, in this case, would further confuse matters.

5. CYTHERIDEA LACUSTRIS (G. O. Sars). (Plate XXVI. figs. 18–21, and Plate XL. fig. 2.)

Cythere lacustris, G. O. Sars, Zoologisk Reise i Sommeren 1862, p. 30.
Cyprideis torosa, Jones (in part), Tertiary Entomostraca, p. 21, pl. ii. figs. 1*a*–1*i*, and woodcut, p. 16. fig. 2.

DISTRIBUTION: *Recent*—Norway, Scotland. *Fossil*—Posttertiary, England.

Valves of the *female* as seen from the side oblong, subtriangular, highest in front; greatest height equal to more than half the length. Anterior margin broad and well rounded; posterior narrowed, obscurely angular above, rounded off below. Superior margin much elevated and angular over the anterior hinge, thence sloping steeply backwards in a right line; inferior straight or very slightly sinuated in front of the middle. Outline, as seen from above, oblong oval, irregularly emarginate; sides nearly parallel; extremities equal and obtusely pointed; width equal to half the length; a deep longitudinal sulcus formed by the depression of the hinge-margins behind the middle. The ventral surface is marked with faint, jagged, longitudinal furrows. End view ovate, broad below, pointed above. The shell is thick and dense in structure, covered with closely set irregular pittings, and with scattered papillæ, each of which seems to be composed of four small points arranged in a rosulate manner; often these are fused so as to form one papilla with a central perforation. Valves transversely sulcate and bearing several irregularly placed rounded tubercles. Colour pale yellowish brown. Hingement that of *Cytheridea*, except that the terminal rounded protuberances are scarcely at all crenated. Limbs very robust. Upper antennæ short and stout; terminal joint linear, considerably longer than either of the two preceding joints, which are about equal in length and very short; the antepenultimate about equal to the following two; spines long and slender. Urticating seta of the lower antenna very short, reaching to the base of the terminal claws. Basal joint of the first pair of feet very stout, about equal in length to the three following joints, bearing on its posterior margin a very stout flexuous seta; second joint narrow at the base and much dilated at the distal extremity; last two joints very short, and distinctly separated; terminal claw slender, slightly curved, and equal in length to the three preceding joints. Second joint of the last pair much longer than the following two, which, like those of the other feet, are much dilated at the apex. Male unknown.

Length $\frac{1}{30}$ in., height $\frac{1}{50}$ in.

Hab. North Shaws Loch, Selkirkshire (*G. S. B.*); Glasgow and Paisley Canal (*Mr. D. Robertson*).

I took one imperfect specimen of this very interesting species in Selkirkshire in 1864, since which time Mr. Robertson has found it more abundantly in the neighbourhood of Glasgow. It occurs fossil in the fluviatile clays of Hornsea, Yorkshire; and at Grays, in Essex.

6. Cytheridea sorbyana, Jones. (Plate XXIX. figs. 1–6.)

Cytheridea sorbyana, Jones, Entom. of Tert. Form. p. 44, pl. iv. figs. 6*a*–6*e*.
—— *dentata*, G. O. Sars (right valve), Oversigt af Norges marine Ostracoder, p. 56.
—— *inermis*, *idem* (left valve), *ibidem*, p. 56.

Scandinavian type (?). Distribution: *Recent*—Norway, Scotland. *Fossil*—Glacial, Scotland and Norway; crag, England.

Carapace, as seen from the side, broadly subtriangular, highest in front of the middle; greatest height equal to two-thirds of the length. Anterior margin broadly rounded, posterior obliquely rounded, narrowed, and exserted below; the right valve bears on the anterior margin six blunt teeth; and its postero-ventral angle has one much longer tooth, which is directed downwards and backwards. Superior margin boldly arched, somewhat gibbous in front of the middle, sloping with a steep curve behind; inferior margin slightly convex in front, straight behind. Outline, as seen from above, broadly oval, with equally rounded extremities, widest in the middle; greatest width equal to two-thirds of the length. Surface marked with irregular concentric rugæ, which are most pronounced towards the margins, and bearing numerous short and rigid scattered hairs, which are papillose at the base. The left valve is much larger, higher, and more rounded, and less attenuated behind than the right, besides being destitute of marginal teeth. Animal unknown.

Length $\frac{1}{30}$ in.

Hab. Off Lewis (*Admiralty soundings*); Hebrides (*Mr. J. G. Jeffreys's dredgings*); off Ormeshead (*Mr. D. Robertson*).

G. O. Sars, having seen only separated valves of this species, has naturally referred them to two distinct specific forms, which is not surprising, considering the great dissimilarity between the right and left valves. I had myself adopted the same course until I saw a perfect carapace (posttertiary fossil), collected by the Rev. H. W. Crosskey in Norway; this at once showed me the mistake. I have figured the Norwegian shell for the sake of better illustration (figs. 2–4), all hitherto found *recent* specimens consisting merely of detached valves.

7. Cytheridea zetlandica, n. sp. (Plate XXVIII. figs. 42–46.)

Valves, as seen from the side, oblong subreniform; greatest height near the posterior extremity, equal to more than half the length. Anterior and posterior margins obliquely rounded; the anterior narrow; the posterior broad and subtruncate. Dorsal margin forming a flattened arch; ventral straight, with a slight median sinuation. Seen from above, the carapace is oval, widest in the middle, rather obtusely pointed in front, broader behind; greatest width equal to half the length. End view obovate, broadly rounded above, pointed below. Lucid spots about five in number; irregularly angular and rather crowded together. Surface smooth, dull yellowish white. Animal unknown.

Length $\frac{1}{27}$ in.

The general appearance of *C. zetlandica* is very like that of *Candona candida*; it has not, however, the polish of the freshwater species. Two or three specimens taken by Mr. Barlee in rock-pools in Shetland, and now in Mr. Norman's collection, are the only

examples that I have seen. Its position in the genus *Cytheridea* must be considered merely provisional.

8. Cytheridea (?) subflavescens, Brady. (Plate XXXIV. figs. 53–55.)

Cythere subflavescens, Brady, Brit. Assoc. Report, 1866, p. 210.

Carapace, as seen from the side, subtriangular, highest in the middle; greatest height equal to rather more than half the length; extremities rounded, anterior broad, posterior somewhat narrowed; superior margin well arched, highest in the middle, where it is obscurely angular, inferior slightly convex. Outline, as seen from above, ovate, pointed in front, rounded behind; greatest width in the middle, scarcely equal to half the length. Surface smooth, finely and closely punctate, very slightly pubescent; colour yellowish. Animal unknown.

Length $\frac{1}{50}$ in.

Hab. The Minch, 45–60 fathoms (*Rev. A. M. Norman*).

One specimen only of this species was found, by Mr. Norman, in sand dredged amongst the Hebrides in 1866.

Genus 4. Eucythere, Brady.

(*Cytheropsis*, G. O. Sars*.)

Carapace high and compressed in front, lower and more tumid behind. Shell thin, pellucid, and marked with conspicuous round white papillæ. Hinge-joint formed on the right valve by a projecting flange or crest, which is received into a corresponding depression of the left valve. "Superior antennæ five-jointed, and in structure almost like those of *Cythere*; inferior much more robust, four-jointed; flagellum (urticating seta) long. Mandibular palp three-jointed; branchial appendage very small. Cutting portion of the first maxillæ weaker than usual; internal segment rudimentary. Second pair of maxillæ very large, dilated in an extraordinary manner at the apex, flabelliform, and beset with numerous apical setæ. Feet weak and slender, subequal; terminal claws long and almost straight, alike in the male and female. Copulative organs of the male unusually small. One eye."

Though one species of this genus, *E. declivis*, is tolerably common on the British coast, I have never yet obtained specimens in such a state of preservation as to allow of the examination of the animal. A deficient supply of specimens has also prevented Sars from making a very accurate investigation of the anatomical structure; but there would seem to be little doubt that there is quite sufficient peculiarity in the shell and internal parts to constitute a distinct genus.

* The name *Cytheropsis*, having been already used by M'Coy in the 'Systematic Description of the British Palæozoic Fossils in the Geological Museum of the University of Cambridge,' 1855, it is necessary to substitute another name for this genus.

1. Eucythere declivis (Norman). (Plate XXVII. figs. 22–26, 52–55.)

Cythere declivis, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 16, pl. v. figs. 9–12, and Brit. Assoc. Report, 1864, p. 192.

? *Cytheropsis tenuitesta*, Sars, *loc. cit.* p. 59.

British type. Distribution: *Recent*—Norway, Great Britain, and Ireland. *Fossil*—Glacial, Scotland.

Valves of the *female* as seen from the side subtriangular, broad and well rounded in front, tapering to a narrowly rounded point behind; greatest height in the middle, equal to considerably more than half the length. Superior margin boldly arched in front of the middle, thence sloping steeply to the posterior extremity; inferior margin gently sinuated in front of the middle. Outline as seen from above oblong, ovate; greatest width equal to about half the length, situated at the posterior third; extremities pointed. End view somewhat pyramidal, the base rounded. Shell pellucid, smooth, or marked with very fine puncta, and beset with distant round white papillæ. Lucid spots three or four in a transverse row, with two (usually coalescent) in front. Carapace of the *male* much more elongated, and less arched on the dorsum; height equal to less than half the length. "Upper antennæ moderately long, the second joint much shorter than the united length of the three following; last joint narrow and linear. Internal lobe of the first maxillæ forming a very small bisetose tubercle; external lobe or palp not larger than the other two, the last joint much longer than the preceding. Branchial lamina subquadrangular, the four external setæ thicker than the others, and more densely ciliated. Feet very slender, terminal claws very long and narrow. Copulative organs very small, distal portion obtusely rounded." This description of the animal, quoted from G. O. Sars, applies to the male only of *E. tenuitesta*.

Length $\frac{1}{45}$ in.

Hab. In depths of 2–60 fathoms. Shetland, Channel Islands, and the Minch (*Mr. Jeffreys's dredgings*); Donegal Bay (*Mr. E. C. Davison*); Lerwick (*Mr. D. Robertson*); Aberdeenshire coast (*Mr. Dawson*); Plymouth, Falmouth, Isle of Skye (*Rev. A. M. Norman*); Northumberland and Durham coasts, 25–46 fathoms, Preston Pans (oyster-ooze), Galway Bay, Roundstone Bay, Devonshire coast, South Wales (*G. S. B.*).

The female of *E. declivis* seems to be very much more abundant than the male; indeed, except two specimens (figs. 54, 55) obtained by Mr. Norman from the Sound of Skye, I have seen no males; and these I conclude to be so simply from their close agreement with Sars's description and with a drawing which he has kindly sent me. I had been disposed (lacking the opportunity of anatomical investigation) to consider the form figured at 49 to be the male of *declivis*; but, in deference to the observations of G. O. Sars, I must for the present refer it to the following species. There is, however, a curiously contorted form which occurs pretty numerously (figs. 52, 53) in a gathering from the Devonshire coast, and which, from its general resemblance, I am inclined to refer to the present species. The bulk of the gathering consists of the ordinary female forms (fig. 22); and there are none answering to the male, unless we consider as such the curved forms here referred to. Without further opportunities of investigation it is impossible to decide the question. Possibly this curved form may be a distinct species; at the same time it may be well to bear in mind the possibility of there being two distinct

males, as has been shown to be the case in some crustacea. A curious roughly punctate and small form, which I suppose to be referable to a variety or stage of growth of this species, is represented at Plate XXV. figs. 49, 50.

2. Eucythere Argus (G. O. Sars). (Plate XXVII. figs. 49–51.)

Cytheropsis Argus, Sars, *loc. cit.* p. 58.

Scandinavian type (?). Distribution: *Recent*—Norway, Great Britain, and Ireland. *Fossil*—Glacial, Scotland and Norway.

Valves of the *female*, as seen from the side, subovate, highest in the middle; height equal to more than half the length. Anterior margin rounded, posterior rather narrower and obliquely rounded; superior margin highest in the middle, thence sloping with a gentle curve towards each extremity, but more steeply backwards; inferior slightly sinuated in front of the middle. Outline, as seen from above, ovate, widest behind the middle, greatest width equal to half the length; obtusely pointed in front, rounded behind. Shell pellucid, thickly set with rounded white papillæ, which are very much larger than those of the preceding species. "Second joint of the upper antennæ about equal to the united length of the following three, last joint short, ending in a strong spine and two or three setæ; lower antennæ short and thick, last joint larger than usual, and armed with two claws, of which the internal is the smaller, the external strong and armed on the anterior margin, towards the apex, with six teeth. Internal segment of the first maxillæ forming a simple spine. Feet very short, terminal claw scarcely longer than the united length of the two last joints."

Length $\frac{1}{45}$ in.

Hab. In shell-sand, Galway Bay (*Prof. Rowney*); Girdler Sand (*Mr. E. C. Davison*); off Holy Island (*G. S. B.*); Shetland (*Mr. D. Robertson*).

My collection contains only two or three specimens (one a female, the others males) from the three first-named localities; but Mr. Robertson obtained a fine series from his Shetland dredgings, off the Isle of Papa.

Genus 5. Ilyobates, G. O. Sars.

Valves thin and pellucid, subovate, truncate behind; smooth and shining, and set with very small distant papillæ. Hinge-joint simple, formed by a slight projection of the left valve, which is received into a corresponding depression of the right. Upper antennæ very stout, five-jointed, the first two joints much thickened, the last three short and bearing long curved spines; lower antennæ four-jointed. Mandibles small, with unusually long slender teeth; palp three-jointed, the second joint elongated, "branchial appendage having two long ciliated setæ and one rudimentary." Maxillæ of the usual form. Feet very short; the first two pairs three-jointed, the last pair four-jointed. "Right foot of the last pair, in the male, prehensile and only three-jointed, terminal claw very large and strong. Abdomen of the female very convex above, the postabdominal lobes bearing two short hairs." Eyes wanting.

ILYOBATES BARTONENSIS (Jones). (Plate XXXIV. figs. 11–14, & Plate XL. fig. 5.)

Cytherideis bartonensis, Jones, Tertiary Entomostraca, p. 50, pl. v. figs. 2*a*, 2*b*, 3*a*, 3*b*.
Ilyobates prætexta, G. O. Sars, *loc. cit.* p. 60.

Scandinavian type. DISTRIBUTION: *Recent*—Norway, Britain, Bay of Biscay. *Fossil*—Tertiary, England.

Carapace of the *female*, seen from the side, elongate, subovate, slightly higher behind than in front; greatest height behind the middle and equal to half the length. Anterior margin evenly rounded, posterior obliquely rounded, almost truncate. Superior margin slightly arched, inferior nearly straight and forming almost a right angle with the posterior extremity. Outline, as seen from above, ovate, tapering in front to an obtuse point, posterior extremity truncate and evenly excavated; greatest width behind the middle and equal to nearly half the length. End view subcircular. Carapace of the *male* much narrower and more elongated. Shell smooth, pellucid, with opaque patches, the brown body of the animal shining through; surface set with small distant papillæ, and, more especially along the anterior and inferior margins, with rather long single hairs. Lucid spots large, quadrangular, four in a transverse row, mostly two or three more in front, and others sometimes scattered irregularly over the valves. Last three joints of the upper antennæ shorter than the preceding one; basal joint of the lower antennæ bearing on the upper margin a brush of long hairs; last joint terminating in three long, slender, nearly equal claws. Terminal claw of the second pair of feet longer than that of the rest. "Basal portion of the copulative organs of the male very large, subquadrangular, armed behind and below with a long spiniform process; distal portion short, acutely produced before and behind."

Length $\frac{1}{35}$ in.

Hab. The Dogger bank off Scarborough (*Mr. Leckenby's dredgings*); the Minch, 45–60 fathoms, and Loch Alsh and Loch Fyne (*Mr. J. G. Jeffreys*); Shetland (*Mr. D. Robertson*).

This is a very peculiar species, and cannot be confounded with any other recent form; but there is one which occurs in some of the older glacial clays which, if not identical with the present, is at any rate very closely allied; it is, however, larger and less elongated, besides presenting other minor differences. It is interesting to note that this, and one or two other species occur (in Britain) only on the Dogger bank, and on the western and northern shores of Scotland.

Genus 6. LOXOCONCHA, G. O. Sars.

(*Normania*, Brady, Zool. Trans. vol. v.)

Valves subrhomboidal in shape, mostly regularly convex; surface usually marked with fine concentric pittings and distant circular papillæ, rarely bearing deep polygonal excavations; ventral margin forming a thin and prominent keel behind the middle; posterior dorsal angle obliquely truncate. Hinge-joint formed by four small teeth, situated at the extremities of the hinge-line, two on each valve, the intervening portion of the valve-margin often finely crenulated. Limbs of the animal slender and colourless. Upper antennæ very slender, six-jointed, the last joint very long, linear, and bearing

long simple setæ; lower antennæ four-jointed, the third joint long and narrow; flagellum long and biarticulate. Mandibular palp three-jointed, bearing a distinct branchial appendage. Lowest seta of the branchial plate of the first pair of jaws deflexed. Feet long and slender, alike in male and female. Abdomen terminated by a hairy conical process; postabdominal lobes bearing two moderately long subequal setæ.

The genus is well characterized by the oblique "peach-stone" outline of the carapace, and by the very slender, setose but non-spinous limbs of the animal. The typical form is well represented by the species described by Dr. Baird under the name *Cythere impressa*, which is common both in a recent state and in the posttertiary formations of England, Scotland, and Norway.

1. Loxoconcha impressa (Baird). (Plate XXV. figs. 35–40, and Plate XL. fig. 4.)

Cythere impressa, Baird, Brit. Entom. p. 173, t. xxi. fig. 9.
—— *viridis*, Lilljeborg, De Crustaceis, p. 168, tab. xviii. figs. 4–6 & 8–13, and tab. xix. figs. 3–5.
—— *flavida*, Zenker, Ueber die Krebsthiere, p. 86, tab. v. B.
—— *carinata*, Brady, Ann. & Mag. Nat. Hist. vol. xvi. (1865) p. 190, pl. ix. figs. 1–4.
—— *rhomboidea*, Fischer, Abhandl. d. bayerischen Acad. d. Wissenschaften, Bd. vii. p. 656 (*fide* G. O. Sars).
Loxoconcha rhomboidea, G. O. Sars, *loc. cit.* p. 62.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland, Bay of Biscay. *Fossil*—Glacial deposits and raised beaches, Norway, Scotland, England, and Ireland.

Carapace of the *female*, as seen from the side, rhomboidal; greatest height in the middle, equal to two-thirds of the length; extremities obliquely rounded, the posterior obliquely truncate above the middle; superior strongly arched, inferior sinuated in front of the middle, and prominently keeled behind*. Outline, as seen from above, tumid, widest in the middle, and tapering evenly to the extremities, which are sharply pointed; width equal to somewhat more than half the length. The shell of the *male* is much lower in front than behind, the dorsal margin straight, and angular at the anterior and posterior extremities; outline as seen from above considerably less tumid than in the female. Surface often covered with a thick calcareous crust, and marked with closely set impressed puncta, which are arranged in more or less regular concentric rows. Young specimens bear in the intervals of the pittings distant elevated papillæ. Hinge-processes very feebly developed, intervening margin crenulated. Colour yellowish white, and, when occurring in tidal pools or amongst seaweed, marked with rather large brown spots. Upper antennæ very slender; the second joint pilose on its anterior margin, and shorter than the united lengths of the two following joints; last two joints about equal in length, each bearing at its apex three or four very long slender setæ. Third joint of the lower antennæ long and narrow, bearing two setæ above the middle of the posterior margin, and finely serrated below. Second joint of the last pair of feet about equal to the conjoined length of the two following joints; last joint finely toothed on its anterior

* In my paper ("Fossil Entomostraca from the Brick-earth of the Nar") the anterior extremity of *C. carinata* is erroneously described as the posterior, and *vice versâ*.

margin. Apical portion of the male copulative organs tuberculated behind, acuminate in front. Eyes distant and separate.

Length $\frac{1}{40}$ in.

Hab. Littoral and in deep water. In shell-sand from the Girdler Sand (Thames), Cowes, Baltimore, and Donegal (*Mr. E. C. Davison*); Isle of Man, Cumbrae, Oban, Lerwick (*Mr. D. Robertson*); Guernsey, Falmouth, Swansea, Youghal, Skye, Stornoway, Tobermory (*Rev. A. M. Norman*); Arran, Roundstone, Galway, and South Wales in shell-sand; Birterbuy and Roundstone Bays; dredged, and in rock-pools, Arranmore and Sunderland (*G. S. B.*); Channel Islands and Hebrides (*Mr. Jeffreys*); Devonshire coast, 60 fathoms (*Mr. Spence Bate*); Norfolk coast (*Mr. D. O. Drewett*).

Loxoconcha impressa is one of the commonest of British species, occurring almost all round our shores, but much more sparingly on the eastern coast. Where it does occur, however, it is usually, as in the west of Ireland, the Isle of Man, and the Firth of Clyde, one of the most abundant species.

The surface-marking varies considerably. Young specimens are smooth, pellucid, finely punctate, and beset with large circular papillæ; but as age advances the shell becomes covered with a thick calcareous crust which obliterates the papillæ, the puncta becoming at the same time coarser and deeper. This state is represented at fig. 40, where a portion of the outer crust (*b*) has been detached, exposing the original shell-surface (*a*). This is interesting as showing one possible source of error in the discrimination of species, many of which have been founded on characters not so distinct as those shown in the two conditions of fig. 40. When I applied the name *carinata* to this species I believed that Dr. Baird's *Cythere impressa* was the species here called, after G. O. Sars, *Cythere villosa*. An examination of the type specimens and of the original description, shows, however, that the term *impressa* refers to the present species.

2. Loxoconcha granulata, Sars. (Plate XXV. figs. 51, 52.)

Loxoconcha granulata, Sars, *loc. cit.* p. 64.

Distribution: Britain, Norway.

Carapace of the *female*, seen from the side, subrhomboidal; greatest height in the middle, and equal to more than half the length. Anterior margin obliquely rounded; posterior forming an obtuse projection in the middle, obliquely truncate above; superior margin very slightly arched, inferior convex, sinuated in front of the middle. Outline, as seen from above, subovate; greatest breadth in the middle, equal to half the length; extremities equal, sharply tapering. The shell of the male is more elongated and straighter on the superior margin, which is also more angular at the extremities. Surface of the valves marked by small and closely set concentric pittings. "Second joint of the inferior antennæ shorter than the three following; last two joints equal, elongated; third joint of the lower antenna almost as in *L. tamarindus*; its anterior border bearing, above the median setæ, some equally distant very short hairs. Second joint of the last pair of feet longer than the two following. Male copulative organs large, basal portion subquadrangular, apical portion produced before and behind into a very slender subulate process. Eyes separate."

Length (male) $\frac{1}{55}$ in.

Hab. In oyster-ooze from Stranraer.

Of this species I have seen only one British specimen, a male, from which the figures here given were taken. It seems to be very closely allied to *L. impressa*, as well as to *L. tamarindus*, and I should scarcely have ventured to describe it as a distinct species, had its peculiarities not been carefully studied by G. O. Sars, and by him considered to warrant its separation. The male has, as Sars observes, very much the same form as the female of *L. tamarindus*; but the shell-structure is much more like that of *impressa*, which the female also resembles in outline.

3. Loxoconcha elliptica, n. sp. (Plate XXVII. figs. 38, 39, 45–48, and Plate XL. fig. 3.)

Valves of the *female*, as seen from the side, subrhomboidal, rather higher in front than behind; height equal to two-thirds of the length. Extremities obliquely rounded. Superior margin arched; inferior sinuated in front of the middle and slightly keeled behind. Seen from above, the outline is oblong-ovate, extremities acuminate; greatest width behind the middle, equal to half the length. Lucid spots curved or comma-shaped; four placed transversely, with one or two at a little distance in front. Surface of the shell smooth and finely punctate, bearing small scattered papillæ, and often incrusted like the preceding species. Colour yellowish brown, with patches of rather darker shade. The *male* is larger, more elongated, and more regularly quadrilateral, the dorsal margin nearly straight and angulated at its extremities; seen from above the outline is more compressed, the sides subparallel. Superior antennæ slender; the second joint equal in length to the two following; last joint considerably longer than the preceding. Inferior antennæ scarcely different from those of the preceding species. Second joint of the third pair of feet equal in length to the two following.

Length (of the *male*) $\frac{1}{40}$ in., (*female*) $\frac{1}{45}$ in.

Hab. In brackish water. Arnold's Pool, Guernsey (*Rev. A. M. Norman*); Girdler Sand, Thames (*Mr. E. C. Davison*); in pools at the mouth of the Seaton Burn and Wansbeck, Northumberland (*G. S. B.*).

4. Loxoconcha tamarindus (Jones.) (Plate XXV. figs. 45–48.)

Cytherideis tamarindus, Jones, Tertiary Entom. p. 49, pl. iii. fig. 4*a*, 4*b*.
Cythere lævata, Norman, Nat. Hist. Trans. Northumb. and Durh. vol. i. p. 18, pl. v. figs. 13–16, and Brit. Assoc. Report, 1864, p. 192.
Loxoconcha longipes, G. O. Sars, *loc. cit.* p. 63.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland, Bay of Biscay. *Fossil*—Crag, England; glacial and raised beaches, England, Scotland, Ireland, and Norway.

Valves of the *female*, as seen from the side, oblong, subquadrilateral, equal in height throughout; length equal to nearly twice the height. Anterior margin evenly rounded; posterior angulated in the middle and obliquely truncate above. Inferior margin straight, terminating behind in an obtuse angle; ventral sinuated in front, slightly convex behind. Outline, as seen from above, oblong-oval, greatest width in the middle, equal to less than half the length; extremities pointed. Shell fragile, pellucid, smooth and polished; marked with a few fine scattered puncta. Colour white or yellowish. "Upper antennæ much more robust than in *L. impressa*, and beset partially with spiniform setæ; second

joint about equal in length to the three following*, last joint very slender and much longer than the preceding; third joint of the lower antennæ shorter and thicker, two setæ attached about the middle of the anterior margin. Feet, especially the last pair, much elongated; the second joint of the last pair longer than the two following joints. Copulative organs of the male much shortened; apical portion indistinctly separate from the basal, acutely produced in front, rounded behind. Eyes distinct." Shell of the *male* slightly more elongated.

Length $\frac{1}{48}$ in.

Hab. Hebrides, the Minch (*Mr. J. G. Jeffreys*); Guernsey, Falmouth, Burrow Island, Skye, Lamlash Bay, and in tide-pools, Herm (*Rev. A. M. Norman*); in shell-sand, Girdler Sand, Margate, and River Ribble (*Mr. E. C. Davison*); Devonshire coast, 5–60 fathoms (*Mr. C. Spence Bate*); Ormeshead, Peterhead, Macduff, Cumbrae, and Shetland (*Mr. D. Robertson*); Aberdeenshire coast (*Mr. Dawson*); Northumberland and Durham coasts, in tide-pools and in 30–46 fathoms; Galway, Roundstone, and Birterbuy Bays, 1–15 fathoms; in shell-sand from Stranraer and South Wales, and in tide-pools, Sunderland (*G. S. B.*); Norfolk coast (*Mr. D. O. Drewett*).

From an examination of Prof. T. Rupert Jones's type specimens, I have no hesitation in referring this species to his *Cytherideis tamarindus*. I have never seen any valves containing the animal, except two or three Norwegian specimens kindly sent to me by Sars.

5. Loxoconcha guttata (Norman). (Plate XXVII. figs. 40–44.)

Cythere guttata, Norman, Nat. Hist. Trans. Northumb. and Durh. vol. i. p. 19, pl. vi. figs. 9–12, and Brit. Assoc. Report, 1864, p. 192.

British type. Distribution: *Recent*—Great Britain, Ireland, Bay of Biscay, Levant. *Fossil*—Glacial and postglacial, Scotland, Ireland.

Valves of the *female*, seen from the side, rhomboidal or peach-stone-shaped; greatest height equal to much more than half the length. Dorsal margin straight or only slightly arched, angular at each extremity. Ventral margin convex, sinuated at the anterior third. The lower half of the anterior border is rounded; the upper half flattened, and sloping backward to its junction with the dorsal border; posterior margin obliquely rounded below, produced into a rounded angular projection about the middle, obliquely truncate and emarginate above. Seen from above, the carapace is ovate, tumid, widest behind the middle; strongly keeled; extremities obtusely mucronate, greatest width equal to half the length. The end view is very broadly ovate, almost circular. The shell of the *male* is much more elongated, the dorsal margin quite straight and obtusely angular at each extremity, ventral margin only slightly convex behind. The greater portion of each valve is covered with large and sharply defined, deep, angular pittings, but these are wanting round the margins: on the ventral surface they coalesce into irregular furrows. Colour straw-coloured, brown, or slaty-blue.

Length $\frac{1}{45}$ in.

Hab. Deep water: Plymouth (*Rev. A. M. Norman*); Devonshire coast, 60 fathoms (*Mr. Spence Bate's dredgings*); Girdler Sand, Thames (*Mr. E. C. Davison*); Aberdeenshire coast (*Mr. Dawson*); in shell-sand from Stranraer, Roundstone, and Galway Bay; Birterbuy Bay, dredged; Norfolk coast;

* As this phrase occurs frequently in the course of the Monograph, it should be stated that the *united* lengths of the following joints are always meant.

Northumberland and Durham coasts, 25–46 fathoms (*G. S. B.*); Ormeshead and Shetland (*Mr. D. Robertson*); Hebrides, 45–60 fathoms (*Mr. J. G. Jeffreys*).

This is a strictly deep-water species, and, though occurring over a wide range of coast-line, is seldom found in great numbers. The only locality in which I have found it at all common is Birterbuy Bay, Ireland, where it is mostly of a deep-brown or slaty-blue colour.

Genus 7. Xestoleberis, G. O. Sars.

Shell very smooth and polished, ornamented with small round distant papillæ, much lower in front than behind, in the female very tumid behind. Hinge-joint formed by a dentated projecting crest of the left, which is received into an excavation of the right valve. Ventral margin of both valves incurved in front of the middle. Upper antennæ six-jointed, the last four joints successively decreasing in length, and bearing very short simple setæ; lower antennæ short, four-jointed, flagellum of moderate length. Mandibular palp four-jointed; "branchial appendage small and bearing only two setæ." Maxillæ as in the preceding genus. Feet short. Postabdominal lobes bearing two setæ. Eyes distinct. Ova and immature young borne within the shell of the female.

This genus is chiefly distinguished by the peculiar form of the carapace, which is very low and pointed in front, elevated and tumid behind, in these respects offering a direct contrast to the genus *Eucythere*, with which, however, in the character of the hinge-joint and of the surface-markings, it to a great extent agrees. Zenker and Sars agree in stating these animals to be viviparous, a character which I have not myself had an opportunity of examining.

1. Xestoleberis aurantia (Baird). (Plate XXVII. figs. 34–37, and Plate XXXIX. fig. 6.)

Cythere aurantia, Baird, Mag. Zool. & Bot. ii. 143, t. v. fig. 26 (1835), and Brit. Entom. p. 171, tab. xxi. fig. 8.

— *nitida*, Lilljeborg, De Crust. ex. ord. trib. p. 169, tab. xix. figs. 6–7.

— *viridis*, Zenker, Anat.-syst. Studien über die Krebst. p. 86, tab. v. A.

Xestoleberis nitida, G. O. Sars, *loc. cit.* p. 67.

Atlantic type. Distribution: *Recent*—Norway, Great Britain, Ireland.

Carapace of the *female*, seen from the side, subtriangular; greatest height a little behind the middle, equal to nearly two-thirds of the length. Anterior margin much narrowed, rounded; posterior very broadly rounded; superior boldly arched, sloping more steeply in front than behind; inferior slightly sinuated in front of the middle. Outline, seen from above, ovate, tapering gradually to a point in front, broadly rounded behind; greatest width behind the middle, equal to half the length. The shell of the male (see fig. 35) differs in being more elongated and scarcely so tumid behind. Shell smooth and polished, bearing very small scattered papillæ. Colour deep brownish orange, or sometimes white; a very conspicuous black or deep-crimson spot in front of the eyes. Second joint of the upper antennæ shorter than the three following; terminal claws of the lower antennæ short, scarcely more than double the length of the last joint; flagellum stout; poison-gland very large and deeply coloured. Second joint of the last pair of

feet much longer than the following two. Terminal claws very short, stout, and bent almost at a right angle. "Distal portion of the male copulative organs narrow, linguiform, and projecting downwards."

Length $\frac{1}{55}$ in.

Hab. Littoral. Dunstanborough (in tide-pools), Arranmore (in tide-pools), Roundstone Bay (1 fathom in mud) (*G. S. B.*); Poole Bay (*Prof. T. Rupert Jones*); Berwick Bay (*Dr. Baird*); Arran, Loch Carron, Guernsey, Herm, and Falmouth (*Rev. A. M. Norman*); Macduff (*Mr. D. Robertson*); Girdler Sand, (*Mr. E. C. Davison*).

This seems to be a strictly littoral species, and, though closely allied to the following, is undoubtedly quite distinct. The principal points of difference are noticed under *X. depressa*.

2. Xestoleberis depressa, G. O. Sars. (Plate XXVII. figs. 27–33.)

Xestoleberis depressa, G. O. Sars, *loc. cit.* p. 68.

? *Cytherina impressa*, Reuss, Foram. u. Entom. d. Kreidemergels v. Lemberg (Haidinger's Abhandl. vol. iv. 1850), p. 48, tab. vi. fig. 5.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Glacial, Scotland and Ireland; cretaceous, Lemberg?

Carapace of the *female* very tumid, breadth much greater than the height; as seen from the side, subtriangular, greatest height somewhat behind the middle, equal to more than half the length. Anterior margin narrow, rounded; posterior obtusely rounded, subtruncate; dorsal margin arched, sloping steeply in front, more rounded behind; ventral slightly sinuated in front of the middle. Outline, as seen from above, tumid, broadly rounded behind, widest at the posterior third, thence tapering to the acuminate anterior extremity; greatest width equal to two-thirds of the length. End view subtriangular, angles well rounded, base nearly flat, height much less than the width. Shell of the *male*, as seen from the side, more elongated and triangular; seen from above, ovate, widest in the middle. Shell pellucid or opaque pearly white, often tinged at the anterior extremity with reddish orange, very smooth and polished, iridescent, studded with small, distant, setose papillæ. The contact margins on the ventral surface marked with transverse hair-like lines. "Antennæ shorter than in the preceding species, second joint of the upper pair shorter than the three following; terminal claws of the lower pair long. Second joint of the last pair of feet about equal in length to the two following, terminal claw very long and curved. Distal portion of the male copulative organs larger than in the preceding species, and broadly lanceolate."

Length $\frac{1}{44}$ in.

Hab. In depths of 2–60 fathoms, and very rarely in tidal pools. Shetland, the Minch, and Channel Islands (*Mr. Jeffreys's dredgings*); Scarpa Flow, Orkney (*Mr. E. C. Davison*); Aberdeenshire coast (*Mr. Dawson*); Cumbrae, Peterhead, and Oban (*Mr. D. Robertson*); Devonshire coast, 60 fathoms (*Mr. C. Spence Bate*); Arran, Tobermorey, Loch Fyne, Stornoway (*Rev. A. M. Norman*); Northumberland and Durham coasts, 25–46 fathoms; Galway, Roundstone, and Birterbuy Bays (*G. S. B.*).

This is one of the most beautiful and most widely distributed of our marine Ostracoda. It is mainly distinguished from the preceding species by the excessively tumid and depressed form of carapace in the female, by the absence of any black spot in front of

the eyes, the uniform white colour of the shell (except where the extremities or dorsum are tinged with orange, which is not a very uncommon occurrence), lastly by the peculiarly beautiful *iridescence* of the shell, a character of constant occurrence in this species, but never, so far as I know, found in *X. aurantia*; I have often observed it even in fossil specimens of *X. depressa*. The chief distinctive character of the animal itself is found in the long terminal claws of the feet and lower antennæ. In habitat it ranges from 2 to 60 fathoms or upwards, while *X. aurantia* is purely littoral. G. O. Sars gives the following interesting account of the development of the young, which, as previously stated, are carried within the shell of the mother during the earlier stages of existence. "We may recognize four distinct stages of development, which are often found in one and the same mother. The first stage is that of the mature egg just escaped from the ovary, in which may be seen the outer membrane and an inner mass of yelk, on one side of which is visible the germinal vesicle. In the next stage the egg assumes a kidney-shape, one side of which (the ventral) is much incurved: one already sees an indistinct appearance of the eyes while there is as yet no trace of the limbs. These first appear in the third stage, and first of all the lower antennæ. The valves are already formed, and present a peculiar shape, being very much produced immediately over the eyes. In the last stage the shell assumes its adult form. The antennæ, of which the upper are still only five-jointed, the mandibles, and maxillæ are already well-developed, whilst the feet are rudimentary, and appear only as pointed inarticulate appendages."

Genus 8. Cytherura, G. O. Sars.

Valves unequal and dissimilar in form, the right more or less overlapping the left on the dorsal margin; surface reticulated, punctated, deeply excavated, or bearing irregularly disposed ribs or protuberances, mostly marked with a central areola of darker colour than the rest of the shell. Carapace oblong or subtriangular, the posterior extremity produced into a more or less prominent beak. Hinge-processes mostly obsolete. Superior antennæ shortly setose, six-jointed, gradually tapering; second joint bearing a rather long seta on the middle of the posterior margin; inferior antennæ five-jointed, terminal claws short; flagellum long, triarticulate. Mandibles robust, with very blunt teeth; "palp three-jointed, branchial appendage small, and bearing only two recurved setæ." Terminal lobes of the first pair of maxillæ long and narrow, "branchial plate bearing on its external margin two non-ciliated setæ, which are directed downwards, and arise from a separate lobe." Feet small, the terminal claws short and curved. Eyes distinct. Copulative organs of the male very complex, provided with several irregular processes and a very long spirally convoluted tube.

The type of this genus, *C. gibba*, Müller, appears to be almost absent from the British shores; but the genus is abundantly represented by other species, sixteen in all. They are the smallest of all the Ostracoda, and, except *C. nigrescens*, occur almost exclusively beyond low-water mark. My specimens (except *C. nigrescens*) have been picked from shell-sand or from dredged mud which has been subjected to a drying-process; and my sole knowledge of the anatomy of the genus has therefore been derived from the littoral species above named, which I find to correspond very accurately with

Sars's description. The three-jointed character of the urticating seta (flagellum) is not noted by Sars, and I cannot say whether it holds good throughout the genus; it is, however, very distinct in all the specimens which I have examined of *C. nigrescens*. The genus is distinctly characterized, externally, by the peculiarly beaked hinder extremity.

1. Cytherura nigrescens (Baird). (Plate XXXII. figs. 50–55, and Plate XXXIX. fig. 7.)

Cythere nigrescens, Baird, Brit. Entom. p. 171, tab. xxi. figs. 4, 4 *a*.
Cytherura nigrescens, G. O. Sars, *loc. cit.* p. 71.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Glacial, Norway, Scotland, Ireland.

Carapace of the *female*, as seen from the side, subovate, greatest height in the middle and equal to half the length; rounded in front, behind produced about the middle into a short obtuse beak; superior margin well arched, inferior slightly incurved. Outline, as seen from above, compressed ovate; greatest breadth behind the middle, and equal to less than half the length; extremities acuminate. The *male* similar, but rather more elongated. Valves smooth or sparingly punctate, and bearing a few small scattered hairs, marked with long, hair-like, radiating lines on the anterior and posterior margins; pellucid at the extremities; central areola convex in front, deeply concave on its hinder margin, often mottled with deep black. Last joint of the upper antennæ very short; the penultimate and antepenultimate nearly equal and much longer than the preceding. Terminal claws of the feet robust and much curved. Second joint of the last pair of feet about as long as the united lengths of the two following. "Apical portion of the male copulative organs small, subtriangular, with acute angles."

Length $\frac{1}{65}$ in.

Hab. Littoral, and in depths up to 10 fathoms. In rock-pools at Sunderland and Arranmore; dredged amongst mud in Roundstone and Birterbuy Bays; in oyster-ooze from Stranraer, and in shell-sand from South Wales (*G. S. B.*); in rock-pools, Herm, Guernsey, and Arran; and in shell-sand from Berwick and Isle of Skye (*Rev. A. M. Norman*); Lerwick, Shetland, Isle of Man, and Oban (*Mr. D. Robertson*); Minch (*Mr. J. G. Jeffreys*); Loch Erribol (*Mr. D. O. Drewett*).

When living between tide-marks this species is always more or less marked with black; sometimes the central areola forms one deep-jet-black patch, but more frequently is flecked with irregular black striæ or spots. Specimens dredged from beyond low-water mark, though showing the outline of the areola, are altogether destitute of colour. The form figured (54, 55) from the Minch was dredged in a depth of about 50 fathoms, and may possibly be distinct; but it approaches *C. nigrescens* so closely that, for the present, I prefer to regard it as a variety only of that species.

2. Cytherura angulata, n. sp. (Plate XXXII. figs. 22–25.)

Carapace, seen laterally, subquadrangular, greatest height in the middle, and equal to about half the length, evenly rounded in front, produced behind above the middle into a rather long, obliquely truncate beak; superior margin evenly arched, inferior slightly

sinuated; the valves are produced laterally, so as to form, at the infero-posteal angle, a sort of projecting ala. Outline, as seen from above, compressed hastate, greatest breadth in the middle, and equal to rather more than one-third of the length; anterior extremity obtusely pointed, posterior rectangular, mucronate. End view ovate. Surface coarsely punctate; areola as in the preceding species, with the same hair-like lines radiating from its borders. Colour pale or deep golden yellow.

Length $\frac{1}{65}$ in.

Hab. Birterbuy Bay, 10 fathoms, in mud, and in shell-sand from South Wales (*G. S. B.*); Lerwick, Shetland, Peterhead (*Mr. D. Robertson*); the Minch (*Mr. J. G. Jeffreys*); Plymouth, and in rock-pools, Arran, N.B. (*Rev. A. M. Norman*).

Well characterized by its excessively compressed dorsal outline, the posterior angulation, and the coarse punctation of the shell, also by the very prominent beak of the supero-posteal angle. I have had no opportunity of examining the animal of this species; nor have I seen any distinction in the carapaces, such as is usually characteristic of the sexes.

3. Cytherura striata, G. O. Sars. (Plate XXXII. figs. 26–29, 62, 64, 65.)

Cytherura striata, G. O. Sars, *loc. cit.* p. 74.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Glacial, Norway, Scotland, Ireland.

Carapace of the *female*, seen laterally, elongate subquadrangular, about equal in height throughout; greatest height equal to less than half the length, evenly rounded in front, produced behind into a large obtusely rounded median process; superior margin nearly straight in the middle, inferior gently sinuated, and ending behind in an obtuse angle. Outline, as seen from above, oblong, sides nearly parallel, width equal to less than half the length, pointed in front; posterior extremity almost rectangular, acuminate in the middle. End view ovate, very tumid below. The *male* very narrow and elongate, almost thrice as long as high, very tumid behind. The shell is very distinctly longitudinally striated, with circular pittings in the grooves (fig. 62); areola obsolete; colour yellowish.

Length $\frac{1}{65}$ in.

Hab. Northumberland coast, 46 fathoms, Birterbuy Bay, 10 fathoms, and in shell-sand from South Wales (*G. S. B.*); Lerwick and Cumbrae (*Mr. D. Robertson*); the Minch (*Mr. J. G. Jeffreys*); Plymouth, Portland, Isle of Skye, and Shetland (*Rev. Mr. Barlee*); Girdler Sand and River Ribble (*Mr. E. C. Davison*); Stornoway, and in rock-pools, Herm (*Rev. A. M. Norman*).

4. Cytherura lineata, n. sp. (Plate XXXII. figs. 30–34, 67.)

Carapace of the *female*, as seen from the side, subovate, length equal to rather more than twice the height, evenly rounded in front, produced into a short obtuse median prominence behind. Dorsal margin gently arched, ventral nearly straight, terminating behind in a minute tooth. Outline, as seen from above, ovate, widest in the middle, about twice as long as broad, obtusely pointed in front, mucronate behind. End view ovate, tumid. The *male* is rather more elongated and compressed, but in other respects

similar to the female. Shell marked with fine elevated striæ, but without any punctation. Central areola similar to that of *C. nigrescens*, sometimes jet-black, often obsolete.

Length $\frac{1}{70}$ in.

Hab. The Minch, 50–60 fathoms (*Mr. J. G. Jeffreys*) ; Isle of Skye (*Rev. Mr. Barlee*).

5. Cytherura cuneata, n. sp. (Plate XXXII. figs. 35–38, 63.)

Atlantic type. Distribution : *Recent*—Great Britain, Ireland, Levant. *Fossil*—Glacial, Scotland.

Carapace of the *female*, as seen from the side, subquadrangular, excessively tumid behind, nearly equal in height throughout, height equal to half the length, anterior margin broadly rounded; posterior obliquely truncate, and produced above the middle into a short obtusely rounded beak; superior margin nearly straight, inferior slightly sinuated. Outline, as seen from above, cuneate, obtusely rounded in front, very broad and centrally mucronate behind; greatest width equal to half the length. End view pentagonal, widest above the middle. *Male* narrower and more elongated. Shell longitudinally striated on its ventral and anterior portions, reticulated over the posterior protuberances, which are bounded below by a more or less distinct crest or rib. Central areola obsolete.

Length $\frac{1}{65}$ in.

Hab. Birterbuy Bay, 10 fathoms, in shell-sand from Preston Pans, Donegal Bay, and South Wales (*G. S. B.*) ; Skye (*Rev. Mr. Barlee*) ; the Minch, and in rock-pools, Herm (*Rev. A. M. Norman*) ; Lerwick, Shetland (*Mr. D. Robertson*) ; Loch Erribol (*Mr. D. O. Drewett*).

6. Cytherura Sarsii, n. sp. (Plate XXXII. figs. 39–42.)

Carapace, as seen from the side, elongate, subrhomboidal, nearly equal in height throughout ; height equal to less than half the length. Anterior border rounded ; posterior obliquely truncate, rounded off above; superior margin nearly straight, inferior rather deeply sinuated. Outline, as seen from above, compressed ovate ; width equal to about one-third of the length, extremities mucronate. Shell pellucid, smooth, bearing a few small scattered hairs, the anterior portion marked with radiating hair-like lines. Areola obsolete.

Length $\frac{1}{50}$ in.

Hab. Amongst oyster-ooze from Stranraer.

Of this very distinct species I have seen only one specimen.

7. Cytherura similis, G. O. Sars. (Plate XXXII. figs. 56–59.)

Cytherura similis, G. O. Sars, *loc. cit.* p. 72.

Distribution : *Recent*—Norway, Great Britain. *Fossil*—Glacial, Scotland, Norway.

Carapace of the *female*, as seen from the side, subquadrangular, nearly equal in height throughout, height equal to more than half the length; anterior margin rounded, posterior produced above the middle into a very short obtuse protuberance ; superior margin arched, nearly straight in the middle, inferior slightly sinuated. Outline, as seen from above, oval, sides nearly parallel, breadth equal to half the length, broadly rounded in

front, mucronate behind. Shell smooth or indistinctly reticulated. Central areola obsolete ("as in *C. nigrescens*," Sars).

Length $\frac{1}{65}$ in.

Hab. In shell-sand from the River Ribble (*Mr. E. C. Davison*) and amongst oyster-ooze from Stranraer (*G. S. B.*), one specimen from each locality; Shetland (*Mr. D. Robertson*).

8. CYTHERURA UNDATA, G. O. Sars. (Plate XXXII. figs. 43–49, 66.)

Cytherura undata, G. O. Sars, *loc. cit.* p. 75.

—— *humilis*, Brady, Brit. Assoc. Report, 1866, p. 210.

Scandinavian type? DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Great Britain, Ireland. *Fossil*—Glacial, Scotland, Ireland, Norway.

Carapace of the *female*, as seen from the side, subrhomboidal; greatest height equal to rather more than half the length. Anterior extremity obliquely rounded, posterior obliquely truncate, and forming a very short projection above; superior margin arched, inferior scarcely sinuated, and forming a distinct angle behind. Outline, as seen from above, oblong, nearly parallel-sided, almost rectangular behind; width equal to less than half the length. The *male* rather more elongated. Shell thick and strong, indistinctly reticulated, and marked with irregular crests or ribs, two or three of which usually run directly forward from a transverse ridge in front of the middle of the valve, thus producing the outline of the letter F. The surface-markings are usually more prominent in the male than in the female. Colour yellowish.

Length $\frac{1}{65}$ in.

Hab. Birterbuy Bay, 10 fathoms, and in oyster-ooze from Stranraer (*G. S. B.*); Shetland, Cumbrae, Macduff, and Oban (*Mr. D. Robertson*); the Minch (*Mr. J. G. Jeffreys*); Stornoway, and in rock-pools, Arran, N.B. (*Rev. A. M. Norman*); Scarpa Flow, Orkney (*Mr. E. C. Davison*).

9. CYTHERURA PRODUCTA, n. sp. (Plate XXXII. figs. 60, 61.)

Valves of the *male*, as seen from the side, oblong, produced into a rounded laterally projecting ala; height equal to less than half the length. Anterior margin rounded, obliquely truncate below, posterior produced in the middle into a long tapering triangular beak; superior and inferior margins nearly straight in the middle, the latter forming nearly a right angle behind. Outline, as seen from above, broadly ovate, widest in the middle, greatest width equal to half the length; extremities strongly mucronate. Surface of the shell irregularly reticulate, polished, the ventral surface longitudinally striated. Central areola broad, somewhat crescentic. The *female* is more tumid, perfectly smooth and polished, without any sculpturing.

Length $\frac{1}{50}$ in.

Hab. Birterbuy Bay, 10 fathoms (*G. S. B.*); the Minch (*Rev. A. M. Norman*); off Ormeshead (*Mr. D. Robertson*).

Apparently a scarce species, three specimens only having been met with from the first-named, and one from the second locality.

10. CYTHERURA AFFINIS, G. O. Sars. (Plate XXXII. figs. 19–21.)

Cytherura affinis, G. O. Sars, *loc. cit.* p. 77.

Carapace of the *female*, as seen from the side, subquadrangular; height equal to half the length. Anterior margin rounded, posterior produced above the middle into a wide, obliquely truncate beak; superior and inferior margins nearly parallel, the former scarcely arched, the latter slightly sinuated in front of the middle. Outline, as seen from above, boat-shaped, ventricose; greatest breadth in front of the middle, and equal to half the length, acuminate behind. Surface of the shell waved and, on the ventral surface, longitudinally striate.

Length $\frac{1}{43}$ in.

Hab. Berwick-upon-Tweed (*Rev. A. M. Norman*); Peterhead (*Mr. D. Robertson*). One specimen from each locality.

11. Cytherura Robertsoni, n. sp. (Plate XXXII. figs. 16–18.)

Carapace of the *female*, as seen from the side, subovate, produced into a lateral ala behind the middle of the ventral margin; height equal to more than half the length. Anterior margin rounded, posterior forming a slight and somewhat rounded protuberance above the middle. Superior margin gently and evenly arched, inferior slightly sinuated. Seen from above, the outline is subrhomboidal, broadest behind the middle, where the width is equal to about two-thirds of the length; extremities slightly mucronate. Ventral surface quite flat. End view broadly triangular, the width greater than the height, basal angles much produced. Surface of the shell very distinctly and regularly marked with a raised reticulation, except on the ventral surface, which is longitudinally striated. The *male* is rather more elongated, more sinuated ventrally, and the alæ not so much produced.

Length $\frac{1}{52}$ in.

Hab. Lang Bank, Cumbrae (*Mr. D. Robertson*), and in rock-pools, Arran (*Rev A. M. Norman*).

This is a very distinct and remarkable species; and I have pleasure in naming it after its discoverer, whose diligent pursuit of marine zoology, as well as his unvarying kindness in assisting me with specimens for the preparation of the present monograph, merit my most cordial acknowledgment.

12. Cytherura gibba, Müller. (Plate XXXII. figs. 68–70.)

Cythere gibba, Müller, Entomostraca, p. 24, tab. vii. figs. 10–12.
—— *gibbera*, idem, ibidem (mas); Lilljeborg, De Crustaceis, p. 167, tab. xix. figs. 1, 2.
—— *gibba*, Zenker, Anat. Studien über die Krebst. p. 84, tab. v. D.
Scandinavian type? Distribution: *Recent*—Norway, Britain.

Carapace of the *female*, as seen from the side, elongated subquadrangular, of nearly equal height throughout, greatest height equal to less than half the length; rounded in front, posterior margin produced into an obtuse beak above the middle; superior margin straight, inferior slightly sinuated. Outline, as seen from above, constricted in the middle, forming a rounded lateral protuberance behind, widest behind the middle; greatest width equal to more than half the length; extremities pointed, the posterior mucronate. End view pentagonal, width greater than the height. "The *male* more elongated, subreniform, upper margin slightly, lower deeply sinuated; seen from above,

sinuated in front of the middle." The shell is closely punctate and divided (especially in the male) into large polygonal areolæ. "Colour deep blackish green towards each extremity, with an obliquely transverse white median band. Last joint of the upper antennæ elongated, equal in length to the preceding; second joint of the last pair of feet much longer than the two following joints; terminal claw curved toward the apex. Copulative organs of the male large, basal portion subquadrangular, with a very long convoluted tube, distal portion obtusely rounded below, divided behind into many irregular processes, of which the lower is large and obtusely pointed."

Length $\frac{1}{45}$ in.

The only specimen of *C. gibba* which I have seen is a female, in the collection of the Rev. A. M. Norman. The locality in which it was taken is unknown.

13. Cytherura cornuta, n. sp. (Plate XXXII. figs. 12–15.)

Distribution: *Recent*—Britain, Dardanelles.

Carapace of the *female*, as seen from the side, subquadrangular, nearly equal in height throughout; height equal to half the length. Anterior extremity broadly rounded, posterior produced above the middle into a large obtusely rounded beak; dorsal margin gently arched; ventral abruptly sinuated in front, produced behind into a sharply defined crest, which terminates in an acute triangular lamina or spine. Outline, as seen from above, somewhat hastate, broadest behind the middle, pointed in front, strongly mucronate behind; greatest width equal to more than half the length. End view triangular, nearly equilateral, base flat and produced at the angles. The shell is faintly sulcate in the middle, the anterior portion marked with almost obsolete polygonal depressions, the posterior irregularly reticulated; ventral surface longitudinally striated, waved.

Length $\frac{1}{43}$ in.

Hab. Birterbuy Bay, 10 fathoms, amongst mud (*G. S. B.*); Cumbrae and Shetland (*Mr. D. Robertson*); Loch Erribol (*Mr. D. O. Drewett*).

C. cornuta is evidently nearly allied to the preceding species, but is distinguished by the acutely angular ventral ala, the less rounded outline, more prominent posterior beak, weaker reticulation of the surface, and, lastly, by its larger size. From *C. acuticostata* it is separated chiefly by the character of the surface-markings.

14. Cytherura acuticostata, G. O. Sars. (Plate XXXII. figs. 1–11.)

Cytherura acuticostata, G. O. Sars, *loc. cit.* p. 76.

Atlantic type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Norway, glacial.

Carapace of the *female* very tumid; seen from the side, subquadrangular, greatest height somewhat exceeding half the length; broadly rounded in front, posterior margin waved, obliquely truncate, and produced above the middle into a rather slender beak; superior margin gently arched, slightly depressed in front; inferior slightly sinuated, and terminating behind in an acute angular spine. Outline, as seen from above, broadly ovate, mucronate behind; width equal to more than half the length. The *male* more elongated, higher in front than behind, the superior and inferior margins more distinctly

concave. Valves marked with several (8–10, Sars) more or less longitudinal acute elevated ribs, one or more of which terminate behind in sharp spinous points. Colour variable—yellowish, brown, or slaty blue.

Length $\frac{1}{50}$ in.

Hab. Off Holy Island (Northumberland), Birterbuy and Galway Bays, and in shell-sand from South Wales (*G. S. B.*); Cumbrae and Shetland (*Mr. D. Robertson*); Loch Fyne, and in rock-pools, Arran, N.B., and Herm (*Rev. A. M. Norman*); Aberdeenshire coast (*Mr. Dawson*); Isle of Skye, Plymouth, Isle of Portland (*Rev. G. Barlee*).

This appears to be the commonest and most widely distributed of the deep-water species of *Cytherura*, often occurring in considerable numbers. It exhibits much variation in the number and direction of the ribs with which the surface of the shell is marked; and I have met with one specimen, apparently referable to the same species, in which the ribs were quite obsolete except on the ventral surface. This specimen is represented (figs. 9–11), and was taken in Birterbuy Bay, Connemara.

15. Cytherura clathrata, G. O. Sars. (Plate XXIX. figs. 43–46.)

Cytherura clathrata, G. O. Sars, *loc. cit.* p. 77.

Scandinavian type? Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Glacial and raised beaches, Scotland and Norway.

Carapace of the *female*, as seen from the side, subtriangular, greatest height in the middle, and equal to nearly two-thirds of the length; anterior margin narrow, rounded, and bearing four or five short broad teeth; posterior margin produced into an obtuse laminar process; superior margin strongly arched in the middle, inferior convex. Outline, as seen from above, subovate, widest in the middle, extremities obtusely mucronate; greatest width about equal to half the length. The shell surrounded in the greatest part of its circumference by a laminar belt or keel. "The *male* lower and less strongly arched above" (Sars). The right valve is much larger than the left. Shell marked with irregularly reticulated ribs; mostly one conspicuous ridge running longitudinally near the middle of the valves, and one or two, which are rather less distinct, branching obliquely from it. Colour brown.

Length $\frac{1}{52}$ in.

Hab. Dredged off Yarmouth (*Mr. D. O. Brown*); Ormeshead and Oban (*Mr. D. Robertson*).

16. Cytherura cellulosa (Norman). (Plate XXIX. figs. 47–50, 60.)

Cythere cellulosa, Norman, Nat. Hist. Trans. Northumberland and Durham, vol. i. p. 22, pl. v. figs. 17–20, and pl. vi. fig. 17.

Cytherura nana, G. O. Sars, *loc. cit.* p. 78.

British type. Distribution: *Recent*—Norway, Great Britain, Ireland. *Fossil*—Glacial, Norway, Scotland.

Valves, as seen from the side, nearly semicircular, except that the infero-posteal angle is broadly and obliquely truncate; greatest height in the middle, and equal to nearly two-thirds of the length; narrow and obliquely rounded in front; produced behind, above the middle, into a short obtuse process. Superior margin very boldly arched,

inferior nearly straight. Seen from above, the outline is compressed oval, the sides nearly parallel in the middle, extremities evenly tapering; width equal to less than half the length. Right valve much overlapping the left. Shell marked with a few large and deep polygonal or irregularly rounded excavations, each of which has a small elevated nodule at the bottom; colour yellowish ("in medio vero colore saturate fusco-violaceo insignis," Sars).

Length $\frac{1}{70}$ in.

Hab. Birterbuy Bay and in shell-sand from Donegal and Roundstone Bays (*G. S. B.*); Lamlash, Berwick, Guernsey, Arran (Ireland), and in rock-pools, Arran, N.B. (*Rev. A. M. Norman*); Cumbrae and Shetland (*Mr. D. Robertson*).

This is the smallest of the genus, and almost the smallest of British Ostracoda. It is also a very distinct and well-marked species, having no near allies except *C. clathrata*, with which, however, it is little likely to be confounded.

Genus 9. Cytheropteron, G. O. Sars.

Valves unequal and of dissimilar form, the right overlapping the left in the middle of the dorsal margin; surface marked with small round impressed puncta or shallow angular pits, sometimes with elevated ribs; ventral surface expanded laterally into a winged process; posterior margin produced into an obtuse beak. Hinge-joint composed of two terminal teeth on the right valve, and on the left a median crenulated ridge. Upper antennæ shortly setose and composed of five joints, penultimate joint elongated and bearing on the middle of the anterior margin two hairs; lower antennæ distinctly five-jointed, flagellum long. Mandibles of moderate size; palp three-jointed, branchial appendage bearing two very small setæ. Jaws as in the preceding genus. Feet long and slender, terminal claw slender. Abdomen ending in a long, narrow process, post-abdominal lobes bearing three short hairs. Copulative organs of the male armed behind with three spiniform processes, one of which is trifurcate. Eyes wanting.

This genus is easily distinguished by the prominent lateral alæ of the shell; the peculiar armature of the male copulative organs is a remarkable characteristic of the internal animal structure.

1. Cytheropteron subcircinatum, G. O. Sars. (Plate XXXIV. figs. 39–42.)

Cytheropteron subcircinatum, G. O. Sars, *loc. cit.* p. 81.

Very similar to the following species, but smaller; the lateral alæ almost semicircularly curved, and not angular. Carapace, as seen from the side, subovate; highest in the middle, greatest height equal to more than half the length, obliquely rounded in front; posterior margin somewhat angularly produced; superior margin forming a flattened arch; inferior nearly straight, but encroached upon by the convex margin of the lateral ala. Outline, as seen from above, very broadly ovate, widest in the middle; greatest width equal to two-thirds of the length, extremities very slightly mucronate. End view triangular, width greater than the height, sides convex, base slightly concave; valves unequal. Surface of the shell faintly pitted, ventral surface longitudinally grooved and bearing a

few small round papillæ. Colour white. "Antennæ and limbs similar to those of *C. latissimum*."

Length $\frac{1}{66}$ in.

Hab. Galway Bay, off the Isles of Arran, in 10 fathoms water (*G. S. B.*).

Like Sars, I at first took this to be the young of the following species; but a minute examination shows decided specific differences, which will be best appreciated by examination of the figures. One specimen only occurred in my dredgings.

2. CYTHEROPTERON LATISSIMUM (Norman). (Plate XXXIV. figs. 26–30.)

Cythere latissima, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 19, pl. vi. figs. 5–8; Brady, Trans. Zool. Soc. vol. v. p. 381, pl. lxii. figs. 4 *a–e*.

Cytheropteron convexum, G. O. Sars, *loc. cit.* p. 80.

British type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Great Britain, Ireland. *Fossil*—Glacial, Scotland, Norway.

Lateral protuberance moderately prominent, obtusely angular behind. Carapace of the *female*, seen from the side, obliquely subovate, greatest height in the middle, and equal to considerably more than half the length; anterior extremity narrowed, rounded; posterior produced in the middle into an obtusely rounded angle. Superior margin arched; inferior convex, slightly sinuated in front of the middle. Outline, as seen from above, subovate, angular behind the middle, thence suddenly tapering to the posterior extremity, which is sharply pointed; greatest width equal to more than half the length. Ventral surface flat, often longitudinally striated. End view triangular, equilateral, base flat, sides convex. Shell of the *male* more elongated. Colour white. Surface of the valves marked more or less distinctly with oblong, slightly curved pittings, running in transverse rows across the shell. "Second joint of the upper antennæ about equal in length to the fourth, the last very short. Second joint of the last pair of feet much longer than the two following. Distal portion of the male copulative organs obtusely truncated at the apex, the trifurcate spine narrow and shorter than the rest."

Length $\frac{1}{40}$ in.

Hab. In depths of from 10–80 fathoms. Shetland (*Mr. J. G. Jeffreys*); Aberdeenshire (*Mr. Dawson*); Loch Fyne (*Rev. A. M. Norman*); Oban, Bute, Cumbrae, Macduff, Peterhead, and Ormeshead (*Mr. D. Robertson*); Northumberland, Durham, and Yorkshire coasts (*G. S. B*); Norfolk coast (*Mr. D. O. Drewett*); in shell-sand from the River Ribble and Isle of Wight (*Mr. E. C. Davison*).

A very pretty and well-marked species, distinguishable from the following (*C. nodosum*) by the less angular outline and the absence of any well-defined transverse ribs and nodes, as well as by its larger size,—from *C. punctatum* also by its much greater size, less pronounced lateral alæ, and the character of the surface-marking. It has been wrongly identified by G. O. Sars with *Cythere convexa*, Baird, a totally different species, which has not yet been noticed on the Norwegian coast.

3. CYTHEROPTERON NODOSUM, n. sp. (Plate XXXIV. figs. 31–34.)

Atlantic type? DISTRIBUTION: *Recent*—Britain, Ireland. *Fossil*—Glacial, Scotland, Ireland.

Similar to the preceding, but much smaller. Carapace of the female, as seen from the

side, oblong, highest in the middle, greatest height equal to less than two-thirds of the length, narrowed and rounded in front, obliquely truncate behind; superior margin strongly arched, inferior rather convex. Outline, as seen from above, broadly ovate, widest behind the middle, extremities pointed; greatest width equal to more than half the length. End view triangular, equilateral, broad at the apex; base flat, sides decidedly concave. The shell is obscurely punctate and rugose, and has two more or less strongly marked rounded ribs running from the central portion of the ala to the extremities of the hinge-margin, and forming, when viewed from above, two large rounded nodes; the ala itself is more angular than in the preceding species. Animal unknown.

Length $\frac{1}{50}$ in.

Hab. Hebrides and the Minch, 50–60 fathoms (*Mr. J. G. Jeffreys*); and in shell-sand from Roundstone (*Dr. Alcock*).

4. Cytheropteron punctatum, n. sp. (Plate XXXIV. figs. 45–48.)

Cytheropteron tricorne, Brady, Brit. Assoc. Report, 1866, p. 208.

Outline, as seen from the side, very similar to the preceding; but the posterior margin is broader and more produced above, and the lateral ala much more exserted and ending suddenly, behind the middle, in an acute angle. Outline, as seen from above, rhomboidal, rectangular behind the middle, thence tapering to the acuminate posterior extremity; or it may be described as consisting of two equilateral triangles applied to each other by their bases, the larger being in front; greatest width behind the middle and equal to nearly three-fourths of the length. Surface of the shell minutely punctate.

Length $\frac{1}{55}$ in.

Hab. The Minch, 60 fathoms (*Rev. A. M. Norman*), and off Ormeshead (*Mr. D. Robertson*).

I was at one time disposed to refer this species to a fossil form described by Herr Bornemann under the name *Cythere tricornis*; and in outline the two are, indeed, very similar; but the fossil species seems to have no punctation of the surface; and as it differs slightly in other respects, it seems better to keep it distinct.

5. Cytheropteron multiforum (Norman). (Plate XXIX. figs. 38–42.)

Cythere multifora, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 18, pl. vi. figs. 13–16, and Brit. Assoc. Report, 1864, p. 192.

Atlantic type? Distribution: *Recent*—Britain, Ireland.

Carapace of the *female*, seen from the side, oblong, rhomboidal, equal in height throughout; height equal to more than half the length; ventral ala not very prominent. Extremities irregularly and obtusely rounded, the anterior oblique and forming an obtuse angle at its junction with the dorsum; superior and inferior margins parallel and nearly straight. Seen from above, the outline is subhexagonal, with suddenly tapering pointed extremities; greatest width equal to much more than half the length; hinge-margins depressed behind the middle so as to form a longitudinal sulcus. End view subtriangular, the three sides convex, apex and base centrally emarginate. Carapace of the *male* more elongated; sides, as seen from above, parallel. Shell-surface marked with closely set

angular fossæ, arranged in more or less distinct longitudinal rows, which are separated by sharp ridges. Colour yellowish brown. Animal unknown.

Length $\frac{1}{50}$ in.

Hab. In depths of 10–60 fathoms, Shetland, Stornoway, Skye, Loch Fyne, Plymouth (*Rev. A. M. Norman*); Oban and Ormeshead (*Mr. D. Robertson*); Aberdeenshire (*Mr. Dawson*); Northumberland and Durham coasts, 25–46 fathoms (*G. S. B.*); Hebrides, the Minch, and Channel Islands (*Mr. J. G. Jeffreys*); Devonshire coast (*Mr. C. Spence Bate*); Roundstone (*Dr. Alcock*).

6. CYTHEROPTERON RECTUM, nov. sp. (*See Appendix.*)

Genus 10. BYTHOCYTHERE, G. O. Sars.

Valves subequal, smooth or very sparingly sculptured, almost destitute of hairs; thin and fragile. Hinge-joint quite simple or composed of a slight bar and furrow; no teeth. Upper antennæ elongated, seven-jointed; the second joint large and thick and bearing a seta on its anterior and posterior margins; the other joints suddenly much narrower, forming a long slender lash, which bears several setæ; penultimate joint linear and destitute of setæ. Lower antennæ tolerably robust, four-jointed; second joint large; flagellum long, biarticulate, its last joint long and setiform. Mandibles constricted above the distal extremity, strongly toothed; palp four-jointed, bearing a well-developed branchial plate, which is set with numerous ciliated setæ. Terminal lobes of the first pair of jaws very short and thick; branchial plate large, ovate, bearing numerous marginal ciliated setæ, and at the base four long and deflexed simple setæ. Feet elongated, terminal claw very long and slender, second and third joints bearing each a short apical seta; basal joint of the first pair furnished at the base with a small lobe, which bears two very large and densely ciliated, and two smaller and simple setæ. Abdomen ending in a very large and acuminated process; postabdominal lobes narrow and bearing three hairs. Eyes mostly absent.

The species grouped under this genus present two very distinct types, so far as the characters of the shell are concerned; but according to the investigations of Herr G. O. Sars, the structure of the animal itself is the same in both types. My own observations of the animal have been made altogether on dried specimens, and are necessarily imperfect, but, so far as they go, they are quite in accordance with those of that most accurate author.

1. BYTHOCYTHERE SIMPLEX (Norman). (Plate XXXIII. figs. 23–27, and Plate XL. fig. 8.)

Cythere simplex, Norman, Nat. Hist. Trans. Northumb. & Durh. vol. i. p. 17, pl. v. figs. 1–4.
Jonesia simplex, Brady, Trans. Zool. Soc. Lond. vol. v. p. 363, pl. lvii. figs. 11 *a–e*.
Bythocythere acuminata, G. O. Sars, *loc. cit.* p. 86.

Scandinavian type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Britain. *Fossil*—Glacial, Scotland.

Carapace of the *female*, as seen from the side, oblong fusiform, about twice and a half as long as broad, rounded in front, acuminate behind. Dorsal margin straight in the middle, sloping suddenly downwards at the posterior extremity, gently rounded in front;

ventral margin sinuated in front, very convex behind. The valves are bordered by a broad, flattened flange, which bulges conspicuously near the middle of the ventral margin, and is lost on the dorsum; the flange is marked by numerous closely set radiating hair-like lines. Outline, as seen from above, elongate fusiform, more than thrice as long as broad, narrowed in front, slenderly acuminate behind, the right valve overlapping the left. Shell of the *male* scarcely different from that of the female. Lucid spots five, forming an oval patch a little below and in front of the centre of the valve; spots parallel, the three central ones linear-oblong, the terminal ones oval or lenticular. Shell perfectly smooth, thin and structureless, pellucid, slightly olivaceous, with arborescent markings of a deeper tint. Hinge-margins straight, quite simple. Last pair of feet in the male subprehensile, last three joints very robust, terminal claw very strong. Distal portion of the male copulative organs large, irregularly triangular, subtruncate at the apex; anterior margin straight, posterior deeply sinuated. No eyes.

Length of female $\frac{1}{20}$ in.

Hab. Off Holy Island, Northumberland, in 45 fathoms; off Scarborough, and in dredgings from Shetland (*G. S. B.*); Dogger bank (*Rev. A. M. Norman*); Aberdeenshire coast (*Mr. Dawson*); off Cumbrae, Bute, and Ormeshead, and at low water-mark in the Isle of Man (*Mr. D. Robertson*); the Minch (*Mr. J. G. Jeffreys*).

This species was first described by the Rev. A. M. Norman, from specimens taken in deep water a hundred miles off the coast of Northumberland, and shortly afterwards by G. O. Sars from Norwegian specimens. Though widely distributed, it seems to be, in point of numbers, rather a scarce species, the only British gatherings in which it has occurred at all abundantly being those from the Aberdeenshire coast and from off Scarborough. It occurs in the Arctic seas, and also in a fossil state in the Scotch glacial clays.

2. Bythocythere constricta, G. O. Sars. (Plate XXXV. figs. 47–52.)

Bythocythere constricta, G. O. Sars, *loc. cit.* p. 85.

Carapace tumid, expanded into an obtusely angular lateral protuberance behind, slightly constricted in the middle; ventral surface nearly flat. Shell of the *female*, as seen from the side, subrhomboidal, rather higher behind than in front; greatest height equal to rather more than half the length; obliquely rounded in front, produced behind above the middle into a short, obtusely rounded (sometimes bluntly toothed) process. Dorsal margin nearly straight; ventral sinuated in front, convex behind. Outline, as seen from above, ovate, widest behind the middle, strongly acuminate behind; greatest width equal to considerably more than half the length. Shell of the *male*, as seen from the side, much more elongated, highest behind; greatest height equal to less than half the length; posterior extremity obliquely truncate, and less produced above. Surface of the shell marked with rather distant, round punctations, which are connected with each other by more or less distinct, depressed lines, thus producing a faint reticulation; ventral surface longitudinally striated, and bearing numerous floccu-lent white papillæ; infero-posteal angle armed (frequently) with 3–5 minute teeth. "Penultimate joint of the upper antennæ longer than the preceding. Second joint of

the last pair of feet longer than the two following;" terminal claw very long and slender. No eyes.

Length $\frac{1}{30}$ in.

Hab. In depths of 10–60 fathoms. The Hebrides and the Minch, Shetland and Channel Islands (*Mr. J. G. Jeffreys*); Aberdeenshire (*Mr. Dawson*); Macduff and Ormeshead (*Mr. D. Robertson*); Northumberland coast and Arranmore, Ireland (*G. S. B.*); Devonshire coast (*Mr. C. Spence Bate*); and in shell-sand from Roundstone (*Dr. Alcock*).

Though widely distributed, this is rather a rare species, and at the same time a very beautiful one. I regret that the specimens in my collection have not enabled me to examine accurately the internal animal structure; and for this reason there may, perhaps, be some doubt as to the sexual relations of the two forms of shell here described and figured. The more elongated (? male) form is the commoner of the two, but in none of my specimens have I found the animal: in one example of the stouter form I found the animal in a rather imperfect state, and have no reason to doubt that it is the female; the greater abundance of the form supposed to belong to the other sex, however, is curious.

3. Bythocythere turgida, G. O. Sars. (Plate XXXIV. figs. 35–38.)

Bythocythere turgida, G. O. Sars, *loc. cit.* p. 84.

"Shell very tumid; lateral protuberance large and obtusely angular behind; ventral surface nearly flat; dorsal evenly arched. Shell of the *female*, seen from the side, subrhomboidal, nearly equal in height before and behind, greatest height equal to much more than half the length; anterior extremity obliquely rounded, posterior somewhat produced above the middle; superior margin a little arched, inferior slightly sinuated; lateral protuberance rather prominent in the middle; seen from above very broad, subhexagonal, greatest width somewhat exceeding the height, and situated behind the middle, tapering gradually in front, suddenly behind; posterior extremity forming an acuminate triangular process. Shell of the *male* a little more elongated, higher behind than in front; superior margin straight in the middle, arched behind. Surface ornamented with a few small rounded impressions, which are larger and more numerous on the ventral surface; posterior margin armed below with five to seven minute teeth. Colour white, with a few red spots on the dorsal aspect. Eyes separate. Penultimate joint of the upper antennæ equal in length to the preceding. Branchial appendage of the mandible-palp bearing eight setæ, gradually decreasing in length towards the front, the two anterior rudimentary, one overlapping the other. Second joint of the last pair of feet shorter than the united length of the two following joints. Apical portion of the male copulative organs produced downwards, elongated, subtriangular or lanceolate."

The single shell figured in Plate XXXIV. was unaccountably lost or mislaid before my drawings were completed. I have no record of the locality; but it was probably taken off Holy Island on the Northumberland coast, and seems to me, from a comparison of the figures with Sars's description, quoted above, to be referable to *Bythocythere turgida*.

Length $\frac{1}{28}$ in.

G. O. Sars gives the following curious description of the male copulative organs. "By a wonderful freak of nature these have the appearance, when seen from the side, of the head of a bald old man. The basal portion represents the skull, the terminal portion the long beard, and the intervening parts the profile with forehead, nose, and mouth. To make the resemblance more complete, some chitinous bands produce, in the proper position, an eye with pupil and highly elevated eyebrows. These organs present in various orders of Crustacea so many variations that, by the help of a little fancy, it is easy to make each species represent some particular object. But here the resemblance is so exact that it must needs strike every observer."

Genus 11. Pseudocythere, G. O. Sars.

Shell thin and pellucid, having no distinct structure, rounded in front, produced behind. Hinge-joint simple. Upper antennæ bearing long setæ, 7-jointed; second joint thick and armed with a single seta on the middle of the anterior margin; last joint very long and narrow, linear, terminating in very long setæ; lower antennæ very slender, 5-jointed; flagellum long and slender. Mandibles small, with slender, curved, unguiform teeth; palp narrow, 4-jointed; branchial appendage bearing long setæ. Terminal lobes of the first pair of jaws narrow; branchial plate large, elongate-ovate, armed towards the base with three curved and deflexed simple setæ. Feet very long and slender. Abdomen ending in a long, slender process; postabdominal lobes almost as in the preceding genus. No eye.

Though very nearly related to the foregoing, the characters given by G. O. Sars appear to be amply sufficient to constitute *Pseudocythere* a distinct genus. The form of the carapace is, indeed, so peculiar as at once to suggest its distinctness; and there are also important differences in the structure of the antennæ and mandibles. The only member of the genus is

Pseudocythere caudata, G. O. Sars. (Plate XXXIV. figs. 49–52, and Plate XLI. fig. 6.)

Pseudocythere caudata, G. O. Sars, *loc. cit.* p. 88.

Carapace of the *male*, as seen from the side, quadrilateral, highest in front; greatest height equal to more than half the length. Anterior margin broad and well rounded; posterior obliquely truncate, produced above into an obtusely conical beak. Superior margin sloping in a somewhat sinuous line from before backwards; inferior slightly sinuated in front, terminating behind in one or two small sharp teeth. The anterior and ventral margins form a thin flattened lamina, which is marked with radiating transverse lines, and is most strongly developed behind. Shell of the female rather more tumid. Outline, as seen from above, compressed, oval, tapering to the extremities, which are slightly mucronate; greatest width in the middle and equal to one-third of the length. Shell smooth, thin, and fragile, bearing scattered short hairs; pellucid, the brown body of the animal showing through the shell. Lucid spots four, linear, parallel, situated obliquely a little in front of the middle. "Last joint of the upper antennæ much longer

than the three following; penultimate joint of the lower antennæ very slender, and twice as long as the preceding. Branchial appendage of the mandible bearing eight backward-pointing setæ. Second joint of the last pair of feet shorter than the two following."

Length $\frac{1}{43}$ in.

Hab. Rare; in depths of 10–60 fathoms. Birterbuy Bay and coast of Northumberland off Holy Island (*G. S. B.*); the Minch, and one dead shell in rock-pool, Herm (*Rev. A. M. Norman*).

Genus 12. Cytherideis, Jones.

Carapace slender, elongate, subovate, tapering towards the front, not much compressed laterally. Hinge-margins nearly simple; shell smooth, finely punctate. The right valve overlapping the left in the centre of the ventral aspect. Animal unknown.

Cytherideis subulata, Brady. (Plate XXXV. figs. 43–46.)

Cythere flavida, Baird, Brit. Entom. p. 168, t. xxi. figs. 12, 12 *a*.

British type. Distribution: *Recent*—Britain, Ireland, Bay of Biscay, Cape Verd, Levant. *Fossil*—Glacial, Scotland.

Carapace, as seen from the side, much attenuated in front, highest behind; greatest height equal to one-third of the length; sharply rounded in front, broadly and obliquely rounded behind. Superior margin sloping with a gentle curve from the middle forwards, nearly straight behind the middle; inferior margin gently sinuated in the middle. Seen from above, the outline is compressed ovate, widest behind, tapering to an acute point at each extremity; greatest width equal to one-third of the length. Shell thin and fragile, yellowish, marked with fine closely set impressed puncta; the anterior and posterior margins with transverse radiating lines; centre of the valves obscurely sulcate transversely. End view circular. Animal unknown.

Length $\frac{1}{40}$ in.

Hab. In shell-sand from the Mumbles, Donegal Bay, and Roundstone (*G. S. B.*); Macduff and Peterhead (*Mr. D. Robertson*); Channel Islands (*Mr. J. G. Jeffreys*); Devonshire coast (*Mr. C. Spence Bate*); Frith of Clyde, Falmouth, and in rock-pools, Herm (*Rev. A. M. Norman*).

All the examples of this species which I have seen are merely empty shells, and therefore I cannot refer it with certainty to its proper position. The shell, though in its lateral aspect very similar to some forms of *Paradoxostoma*, differs in some important particulars: it is not laterally compressed as all the elongated forms of the latter genus are; the shell is more horny in character, and not smooth and polished. The lucid spots are four, large, quadrangular, and irregularly grouped. Lastly, the overlapping ventral margin of the right valve almost certainly proclaims that it cannot belong to that genus, which always exhibits a longitudinal aperture between the two contact-margins in front, for the protrusion of the suctorial apparatus. Under these circumstances, I have retained for this species the generic term *Cytherideis*, under which group, as originally defined by Professor Rupert Jones, it would naturally fall. Müller's *Cythere flavida*, with which Dr. Baird identifies it, seems to me to belong to another species, probably *Paradoxostoma variabile*.

Genus 13. Sclerochilus, G. O. Sars.

Valves elongated, very hard, especially towards the margins; surface smooth and shining, ornamented with very minute scattered papillæ. Hinge-joint formed by a projecting median crest of the left valve. Antennæ robust; second joint of the upper bearing a seta on the anterior and posterior margins, the last five joints quickly decreasing in size and bearing numerous long setæ; lower antennæ larger than the upper, 5-jointed; flagellum long and very slender. Poison-glands very large, and divided into many lobes. Mouth produced, conical; labrum strongly toothed. Mandibles small; teeth numerous and acuminate; palp narrow, indistinctly 3-jointed, with a distinct branchial appendage. Terminal lobes of the first pair of jaws partly wanting; branchial plate narrow, almost lanceolate, and set with numerous setæ on the outer and inner margins. Feet short and robust; second and third joints armed in front with a short seta; first pair armed with a single strong spine at the apex of the basal joint. Postabdominal lobes larger than usual, forming broad bilobed laminæ, and bearing five setæ. Eye single.

In outward appearance the one species belonging to this genus is scarcely separable from the following (*Paradoxostoma*); but the structure of the animal shows an apparent transition from the *Cythere* type to that of *Paradoxostoma*. This is more especially evident in the mandibles and mouth.

Sclerochilus contortus, Norman. (Plate XXXIV. figs. 5–10, and Plate XLI. fig. 7.)

Cythere contorta, Norman, Ann. & Mag. Nat. Hist. vol. ix. 1862, p. 48, pl. ii. fig. 15; and Trans. Tyneside Nat. Field Club, vol. v. p. 150, pl. iii. fig. 15.

Sclerochilus contortus, G. O. Sars, *loc. cit.* p. 90.

British type. Distribution: *Recent*—Britain, Norway, Bay of Biscay. *Fossil*—Glacial and raised beaches, Scotland, Ireland, Norway.

Carapace of the *female*, seen from the side, elongated, bean-shaped, higher behind than in front; greatest height rather behind the middle, and equal to considerably less than half the length. Anterior and posterior margins rounded; superior boldly arched, sloping steeply in front, inferior deeply sinuated in front, convex behind. Outline, as seen from above, compressed oval, more than twice as long as broad; greatest width behind the middle, tapering to the extremities, the anterior of which is the more acutely pointed. Shell of the *male* more elongated, the dorsal margin less convex. Shell smooth and polished, very sparingly punctate, the margins marked with short transverse, radiating striæ. Colour yellowish, with a reddish-brown patch on the dorsum. Lucid spots five, linear-oblong, parallel. Third joint of the upper antennæ not shorter than the preceding, and about equal to the united lengths of the three following. "Branchial appendage of the mandibular palp bearing four long, subequal setæ." First pair of jaws having only two terminal lobes, one of which is very narrow, and terminated by a hooked spine. Second joint of the last pair of feet shorter than the two following. Basal portion of the male copulative organs semiovate; upper and anterior margin forming a continuous arch; distal portion smaller, subovate, narrowed to the base.

Length $\frac{1}{33}$ in.

Hab. This species occurs from low-water mark to the greatest depths that have yet been dredged in the British seas. Shetland, Frith of Clyde, Skye, Youghal, Plymouth (*Rev. A. M. Norman*); Aberdeenshire coast (*Mr. Dawson*); Hebrides and Channel Islands (*Mr. J. G. Jeffreys*); Devonshire (*Mr. C. Spence Bate*); Cumbrae, Macduff, Peterhead, and Ormeshead, and at low water-mark, Isle of Man (*Mr. D. Robertson*); Northumberland and Durham coasts (30–46 fathoms); Birterbuy Bay and in oyster-ooze from Stranraer (*G. S. B.*); Norfolk coast (*Mr. D. O. Drewett*); and in shell-sand from the Girdler Sand, Margate, and Donegal (*Mr. E. C. Davison*).

One of the most widely distributed, and, in most localities, one of the more abundant species. It is readily distinguished from all others by its peculiarly flexuous outline.

Genus 14. Paradoxostoma, Fischer.

Shell thin and fragile, smooth, shining, and having no definite structure; valves subequal, mostly much higher behind than in front, usually elongate-ovate. Lucid spots as in the preceding genus. Hinge-joint simple. Ventral margins emarginate in front, so that when the valves are closed there is still an elongated orifice, through which the suctorial mouth can be protruded. Upper antennæ exceedingly slender, 6-jointed, and bearing short setæ; lower shorter and more robust, 5-jointed; flagellum large and almost as thick as the antenna itself. Poison-glands large and mostly lobulated. Mouth suctorial. Labrum and labium forming together a large and stout subconical process projecting downwards, and terminating in a disk with elevated margins, in the middle of which the orifice of the mouth is situated. Mandibles very slender, protractile, styliform, subulate at the apex; palp very slender and elongated, indistinctly jointed, and without a branchial appendage. Terminal lobes of the first pair of jaws very narrow; branchial plate elongate-ovate, and bearing at the base two deflexed setæ. Feet short and robust, last joint elongated, terminal claw very short and curved; basal joint of the first pair armed at the apex with a single strong spine. Postabdominal lobes bearing two short hairs. One eye.

The peculiar characters of the mouth in this genus were first noticed by Fischer, and by him were justly made the ground of separation from other Cytheridæ*; these observations were made on species found in Madeira. Herr G. O. Sars, however, has described with much more minuteness and accuracy, in his 'Oversigt af Norges marine Ostracoder,' to which reference has so frequently been made in these pages, the anatomical characters of the genus. The suctorial mouth and the stylet-shaped mandible are very extraordinary, and show an interesting approximation to the structure of the mouth-organs in the parasitic Copepoda. It is not likely, however, that the members of this genus are in any sense Epizoa; they have never been taken in situations at all different from those frequented by other Ostracoda, being constantly met with on the fronds of algæ in littoral situations, or in the mud and ooze of considerable depths of water. Indeed we cannot doubt that the piercing and suctorial apparatus with which they are armed is used, not for the abstraction of the vital juices of any large animal, but simply as a means of appropriating the nourishment found in the monads and other minute animal prey on which the Crustacea appear mostly to subsist. Sars, indeed, conjectures that it

* Abhandl. d. kgl. bayerischen Akademie d. Wissenschaften, Bd. vii.

may be employed to puncture the epidermis of algæ, and afterwards to abstract the juices of the plant; but in this case one fails to see any use for the exceptionally large poison-glands and urticating setæ with which the members of this genus are armed. Altogether it appears to me more conformable to what we know of the general habits of the Crustacea, and more fully explanatory of the peculiarities of the Paradoxostomata, if we suppose their diet to consist of microscopic animalcula, rather than the juices of algæ or of animals much higher in organization than themselves.

1. PARADOXOSTOMA VARIABILE (Baird). (Plate XXXV. figs. 1–7, 12–17, and Plate XLI. fig. 8.)

Cythere variabilis, Baird, Trans. Berw. Nat. Club, i. 98, tab. iii. figs. 7 *a*, *b* (1835), and ii. 153; Brit. Entom. p. 170, tab. xxi. figs. 10, 11.

Paradoxostoma variabile, G. O. Sars, *loc. cit.* p. 93.

? *Cythere flavida*, Müller, Entomostraca, p. 66, tab. vii. figs. 5, 6.

British type. DISTRIBUTION: *Recent*—Baffin's Bay, Britain, Norway. *Fossil*—Glacial and raised beaches, Norway, Scotland, Ireland.

Carapace of the *female*, seen from the side, elongate-ovate, much attenuated in front, highest behind the middle; greatest height equal to not more than half the length. Anterior margin narrowly, posterior very broadly and obtusely rounded, often slightly angulated above; superior margin well arched, sloping rather steeply in front; inferior straight or but slightly convex in front, much more convex behind. Outline, as seen from above, compressed ovate, tapering gradually to each extremity; greatest width behind the middle, and equal to more than one-third of the length; extremities pointed. The shell of the *male* is similar to that of the female. Valves pellucid, white, slightly olivaceous or ochreous; marked with arborescent black or violet patches, and often with two more or less distinct dark transverse bands. Second and fourth joints of the upper antennæ nearly equal in length, longer than the third, and very much longer than the united lengths of the fifth and sixth. Terminal claws of the lower antennæ very short and subequal; flagellum robust, triarticulate. First pair of jaws having only three uniarticulate lobes, two of which are nearly equal in length, the other more than twice as long. Last joint of the third pair of feet very long and narrow, densely ciliated on the anterior margin. Basal segment of the male copulative organs exceedingly large and rounded, distal segment very small and twisted, bipartite, the anterior portion narrow and obtuse, the posterior expanded and acuminate.

Length $\frac{1}{35}$—$\frac{1}{32}$ in.

Hab. Berwickshire and Dover (*Dr. Baird*); plentifully in rock-pools on the Northumberland and Durham coasts, and in shell-sand from Guernsey (*G. S. B.*); at roots of *Laminaria*, Tobermory; Isle of Skye, Arran, and Herm (*Rev. A. M. Norman*); Falmouth (*Rev. Mr. Barlee*); dredged off Cumbrae (*Mr. D. Robertson*); Girdler Sand, Thames (*Mr. E. C. Davison*).

It seems to me very probable that (as has been suggested by Sars) Müller's description of *Cythere flavida* has been taken from the ochreous variety of this species; but, considering the doubt which must attach to this supposition, and the fact that the name

flavida is by no means a generally appropriate one, it seems better to retain the name proposed by Dr. Baird.

2. PARADOXOSTOMA ABBREVIATUM, G. O. Sars. (Plate XXXV. figs. 22–25.)

Paradoxostoma abbreviatum, G. O. Sars, *loc. cit.* p. 94.

Atlantic type? DISTRIBUTION: *Recent*—Britain, Ireland, Norway. *Fossil*—Glacial, Scotland.

Carapace of the *female*, as seen from the side, much shorter and higher than the preceding, greatest height behind the middle, and equal to about two-thirds of the length; extremities rounded, anterior narrow, posterior excessively broad; superior margin boldly arched, inferior deeply sinuate in front, very convex behind. Outline, as seen from above, compressed ovate, about three times as long as broad. Colour whitish or pale yellow. "Shell of the *male* and young female lower, inferior margin less convex behind. Third joint of the upper antennæ much shorter than the preceding, fourth elongate, and about twice as long as the following two united; terminal claws of the lower antennæ unequal, the anterior about twice as long as the posterior. First pair of jaws almost as in the preceding species. Last joint of the third pair of feet very slightly ciliated. Distal portion of the male copulative organs large, subhamate, or armed behind with a spiniform curved process."

Length $\frac{1}{45}$ in.

Hab. Mostly beyond low-water mark. Plymouth Sound, 5 fathoms (*Mr. C. Spence Bate*); Girdler Sand and Race's Bank (*Mr. E. C. Davison*); Lerwick and Cumbrae (*Mr. D. Robertson*); Lamlash (living in tide-pools), Skye (*Rev. A. M. Norman*).

The validity of this species seems to me open to considerable doubt; and had it not been for the slight differences of animal structure noticed by G. O. Sars, I should have certainly considered it merely a variety of the preceding. Unfortunately, all the specimens which I have seen are merely dried shells, and I have therefore had no opportunity of myself examining the recent animal. But the differences described by Sars are after all very slight, and perhaps do not amount to more than ought to be allowed as merely varietal. This can only be decided by further examination of this and such intermediate forms as those figured (figs. 1–3, 12, 13), which it is now difficult to refer with certainty either to *P. variabile* or *P. abbreviatum*. The form represented in figs. 14–16 is, I believe, referable to the young of *P. variabile*.

3. PARADOXOSTOMA NORMANI, n. sp. (Plate XXXV. figs. 39, 40.)

Carapace of the *female*, as seen from the side, subreniform, much narrowed in front, highest in the middle; greatest height equal to half the length; extremities rounded, the anterior narrow and produced, posterior broad. Superior margin arched, highest in the middle, sloping steeply in front; inferior deeply sinuated in front of the middle, convex behind. Outline, as seen from above, ovate; extremities pointed, widest in the middle; greatest width equal to one-third of the length. Shell pellucid, marked with dendritic black patches, the brown body of the animal shining through the shell. Fourth joint of the upper antennæ more than twice as long as the fifth; lower antennæ short, terminal

claws unequal, one large, the other very short and slender. Terminal claw of third foot long and slender, finely ciliated on the anterior margin; the preceding joints not ciliated.

Length $\frac{1}{45}$ in.

Hab. Isle of Skye, Herm, and Plymouth (*Rev. A. M. Norman*).

4. Paradoxostoma pulchellum, G. O. Sars. (Plate XXXV. figs. 41, 42.)

Paradoxostoma pulchellum, G. O. Sars, *loc. cit.* p. 95.

Carapace of the *female* much compressed; seen from the side, nearly semicircular, rather more tapered in front than behind; greatest height in the middle, and equal to rather less than half the length. Extremities rounded, the anterior rather the narrower of the two; superior margin evenly arched, inferior very slightly sinuated in the middle. Outline, as seen from above, much compressed, nearly four times as long as broad. Shell pellucid, yellowish, with deep-black or violet dendritic markings scattered irregularly over the dorsum and centre of the valves. "Third joint of the upper antennæ scarcely shorter than the preceding, and longer than the following; last two subequal, their united lengths not shorter than the preceding one. Lower antennæ very slender, bearing one small terminal claw. Jaws and feet almost as in *P. abbreviatum*. Male unknown."

Length $\frac{1}{50}$ in.

Hab. In rock-pools, Guernsey, Herm, and Stornoway (*Rev. A. M. Norman*).

A very distinct and pretty species, well worthy of the name bestowed upon it by Sars. The colouring of the specimens collected by Mr. Norman does not exactly agree with Sars's description ("in medio vero fascia lata transversali colore saturate obscure-violaceo instructæ), though in some cases there is an indication of a transverse band; but very little stress can be laid upon this point, especially in the present genus.

5. Paradoxostoma obliquum, G. O. Sars. (Plate XXXV. figs. 18–21.)

Paradoxostoma obliquum, G. O. Sars, *loc. cit.* p. 97.

Carapace of the *female* tumid, seen from the side subrhomboidal; greatest height in the middle, equal to more than half the length. Anterior extremity rounded, much narrowed; posterior obliquely truncate, its upper angle produced; superior margin strongly arched, sloping steeply in front, where it is also slightly incurved; inferior gently convex. Outline, as seen from above, ovate, fully twice as long as broad. End view nearly circular. The right valve is of a shape different from the left, being higher and overlapping on the antero-dorsal and postero-ventral margins. *Male* unknown. Shell smooth, pellucid, fawn-coloured, without any maculæ.

Length $\frac{1}{35}$ in.

Hab. Abundantly in shell-sand from Roundstone (*Dr. Alcock*); in oyster-ooze from Stranraer (*G. S. B.*); Sound of Skye, and in tide-pools at Arran, N.B., and Herm (*Rev. A. M. Norman*); Shetland (*Mr. D. Robertson*).

Of this very well-marked species I have been able to dissect only one specimen (Stranraer), and the animal was not in sufficiently good preservation to enable me to do

more than satisfy myself respecting its sex and genus. Though very abundant in the shell-sand from Dog's Bay, near Roundstone, these specimens consist only of detached valves; and I have not detected it in my own dredgings from Roundstone and Birterbuy Bays.

6. Paradoxostoma hibernicum, n. sp. (Plate XXXV. figs. 35, 36, and Plate XL. fig. 7.)

Carapace of *female*, as seen from the side, oblong subelliptical, rather higher behind than before; greatest height equal to less than half the length. Extremities nearly equally rounded; superior margin gently and evenly arched; inferior slightly sinuated in front. Outline, as seen from above, compressed oval; extremities equally acuminate; greatest width in the middle, equal to rather more than one-fourth of the length. *Male* unknown. Shell smooth and polished; colour (of spirit specimens) a uniform ashy grey. Upper antennæ very slender, one very short slender seta at the apex of the third and fourth joints; fourth joint nearly twice as long as the third, and more than twice as long as the fifth and sixth united; fifth joint twice as long as the sixth. Terminal claws of the feet short, thick, and abruptly curved; penultimate joint of the third foot much less than half the length of the preceding, bearing five strong spinous setæ on the anterior margin. Basal portion of the male copulative organs moderately large, rounded; distal portion small, elongated triangular, acuminate.

Length $\frac{1}{38}$ in.

Hab. In rock-pools amongst the smaller algæ, Great Isle of Arran, Ireland (*G. S. B.*); Arran, N.B., and Loch Carron, Ross-shire (*Rev. A. M. Norman*).

7. Paradoxostoma sarniense, n. sp. (Plate XXXV. figs. 26–29, and Plate XL. fig. 9.)

Carapace of the *female*, seen from the side, oblong elliptical, rather higher behind than in front; dorsal and ventral margins nearly parallel, greatest height equal to less than half the length. Anterior extremity obtusely, posterior obliquely rounded; superior margin perfectly straight; inferior straight in front, convex behind, much compressed, and forming a prominent keel. Outline, as seen from above, excessively compressed, more than four times as long as broad, extremities equally pointed. Shell smooth, pellucid, ornamented on the dorsal and ventral portions of the valves with dendritic black or dark-brown markings. Lower antennæ very slender, scarcely thicker than the stout but slenderly pointed flagellum; one terminal claw. Penultimate joint of the third foot one-third the length of the preceding, anterior margin finely ciliated; terminal claw slender. *Male* unknown.

Length $\frac{1}{40}$ in.

Hab. Guernsey and Herm, in rock-pools, and Falmouth (*Rev. A. M. Norman*); and in shell-sand from the Channel Islands (*G. S. B.*).

A very beautiful and remarkable species, differing from the preceding chiefly in its colouring, its less flexuous outline, and its greater lateral compression.

8. Paradoxostoma ensiforme, n. sp. (Plate XXXV. figs. 8–11.)

Atlantic type. Distribution: *Recent*—Britain, Ireland. *Fossil*—Glacial, Scotland, Ireland.

Carapace, as seen from the side, elongate siliquose, highest behind the middle; greatest height equal to much less than half the length. Anterior extremity much narrowed, rounded; posterior produced, and somewhat angular in the middle; superior margin well and evenly arched; inferior nearly straight in front, convex behind. Outline, as seen from above, ovate, fully thrice as long as broad, broadest in the middle; extremities equally acuminate. Colour dull yellowish white. The animal, so far as I have been able to ascertain from dried specimens, exactly resembles *P. variabile*, except in the various parts being more slender and elongated.

Length $\frac{1}{32}$ in.

Hab. In shell-sand, Girdler Sand, estuary of Thames, and Donegal Bay (*Mr. E. C. Davison*); the Minch (*Mr. Jeffreys's dredgings*); Shetland and Peterhead (*Mr. D. Robertson*); Plymouth, Swansea, and Herm (*Rev. A. M. Norman*).

P. ensiforme appears to be perfectly distinct from any other described species, though in general outline it rather approaches the form of *P. variabile*, figured at Plate XXXV. figs. 12, 13. The chief characteristics of the present species are its attenuated and flexuous form, the median angulation of the posterior, and the comparatively slight compression or keel-like projection of the ventral margin.

9. PARADOXOSTOMA FLEXUOSUM, Brady. (Plate XXXV. figs. 30–34.)

Bythocythere? flexuosa, Brady, Brit. Assoc. Report, 1866, p. 211.

Carapace, as seen from the side, sublinear, flexuous, highest in the middle, greatest height equal to one-third of the length; obliquely rounded, and sloping steeply in front, tapering to an obtusely angular median process behind; superior margin evenly and gently arched; inferior sinuated in front, convex and compressed behind. Outline, as seen from above, compressed, ovate, four times as long as broad; extremities acuminate. Colour yellowish white. Animal unknown.

Length $\frac{1}{42}$ in.

Hab. Hebrides and the Minch, 45–60 fathoms (*Mr. J. G. Jeffreys's dredgings*); Birterbuy Bay, 10 fathoms (*G. S. B.*); Plymouth (*Rev. A. M. Norman*); Girdler Sand, Thames (*Mr. E. C. Davison*).

10. PARADOXOSTOMA? ARCUATUM, n. sp. (Plate XXXV. figs. 37, 38.)

Carapace, as seen from the side, elongate, curved, highest in the middle; greatest height equal to little more than one-third of the length; attenuated and rounded in front, obliquely rounded behind; superior margin boldly and evenly arched; inferior sinuated in front of the middle, slightly convex behind; anterior and ventral margins compressed and marked by radiating transverse lines. Outline, as seen from above, compressed ovate, broadest behind the middle; greatest width equal to one-fourth of the length. Colour pearly white. Animal unknown.

Length $\frac{1}{45}$ in.

Hab. Birterbuy Bay, 10 fathoms.

One specimen only found.

Section II. MYODOCOPA, G. O. Sars.

Fam. 1. Cypridinidæ, Baird.

Shell mostly hard and compact in structure, smooth or punctate, and sometimes beset with short hairs, notched at the antero-inferior angle, so that when the valves are closed there remains still a large aperture for the protrusion of the lower antennæ. Upper antennæ large, geniculated at the base, many-jointed, and bearing, especially towards the apex, several long ringed setæ. Basal portion of the lower antennæ broadly triangular, bearing a slender secondary branch, which is set with a few short setæ, and a large natatory branch, which is mostly nine-jointed, and bears several long ciliated setæ. Mandibles rudimentary, the palp very large, geniculated, pediform, four-jointed; first joint large and thick, bearing at the apex a slightly setose appendage, like a rudimentary branchial plate; last joint very short and strongly clawed. Three pairs of jaws, somewhat pediform. First pair of jaws having four spinous lobes, the exterior or largest biarticulate; first joint large, elongated, subquadrangular; last very short, and set with numerous spines or claws. Second pair of jaws short and stout, composed of several setose or unguiculate segments; the exterior short, three-lobed, and beset with short finely ciliated setæ, bearing at the base a very large semilunar branchial plate, which is provided with numerous marginal setæ. Third pair of jaws smaller, composed of three spinous lobes, beneath which is a membranous subovate plate, beset with many finely ciliated setæ; one pair of feet, forming a very long, flexuous, subcylindrical annulose body, which is armed towards the apex with long prickly spines. Postabdomen large, composed of two broad closely appressed laminæ which are armed posteriorly with strong marginal claws. Two compound pedunculated eyes, between which is a large simple eye, and at its base a short cylindrical tentacle. Male of less height than the female; eyes more developed; copulative organs of complex structure. Ova and embryos borne beneath the shell of the female.

The foregoing description of this family is adopted, with very slight alteration, from the definition of G. O. Sars. The Cypridinidæ are comparatively scarce in the seas of temperate latitudes, but much more abundant in the tropics, constituting, indeed, a not unimportant part of the phosphorescent agencies there so strikingly developed. Many species and genera have been described by various authors, but, except in a few cases, their anatomical structure has not been thoroughly investigated.

In the British seas the few species which have hitherto been discovered are taken mostly by the use of the towing-net at night. Some have occurred amongst dredged sand, and some have been taken by the hand-net amongst *Zostera* in tide-pools; but this seems to be an exceptional circumstance. The animals are essentially of natatory character, their powerful antennæ having free play, even when the valves are quite closed, through the large aperture which is characteristic of the family.

Genus 1. Philomedes, Lilljeborg.

Valves elongated, thin; notch broad, anterior extremity obtuse. Upper antennæ six-jointed, scarcely attenuated at the apex; antepenultimate joint bearing a stout seta,

which is set with numerous long auditory cilia; last joint short, and bearing two setæ, which are much longer than the antenna itself. Lower antennæ very robust, basal portion large and thick, natatory branch very long, nine-jointed, the first three joints elongated, the rest short, subequal, and set with long plumose cilia; secondary branch larger than usual, geniculated, three-jointed, last joint turned upwards. Basal portion of the mandibular feet bearing at the apex a small tubercle, with two short hairs, "forming a rudimentary incisive portion of the mandible; penultimate joint shorter than in *Cypridina*, the anterior marginal setæ fewer and fasciculate. First pair of jaws slender, palp bearing simply a small trisetose lobe; second pair of jaws having neither a mandibuliform appendage nor clawed spines; terminal lobes small, and bearing simple hairs." Eyes large, subelliptical, far separated, and situated near the middle of the shell. Animal swimming with long jerks.

PHILOMEDES INTERPUNCTA (Baird). (Plate XXXIII. figs. 10–13, and Plate XLI. fig. 3.)

Cypridina interpuncta, Baird, Proc. Zool. Soc. Lond. part 18 (1850), p. 257, plate xvii. figs. 8–10 (Annulosa).

Philomedes longicornis, Lillj. De Crustaceis, p. 176, tab. xxvi. figs. 4–6, 14–16; Norman, Ann. & Mag. Nat. Hist. vol. viii. p. 280, plate xiv. fig. 11; G. O. Sars, *loc. cit.* p. 107.

Carapace, as seen from the side, oblong-oval, nearly twice as long as high; dorsal margin nearly straight, almost perpendicularly deflexed behind, gently curved downwards in front; ventral margin gently convex. Anterior extremity obtusely pointed; oral notch situated below the middle, wide, its margins densely setose; posterior extremity broad, obliquely truncate, bearing a short spine near its lower, and sometimes a similar one near its upper termination. Outline, as seen from above, narrow ovate; greatest width in front of the middle, equal to much less than half the length. End view. ovate, tumid, the notch showing as a diamond-shaped opening. The shell is yellowish, horny, and translucent (except in old specimens), showing the animal clearly through it; surface marked with a fine reticulated pattern, similar to that of *Candona compressa* (see Plate XXVI. fig. 26), but the meshes larger, often finely punctate. Second joint of the upper antennæ large, longer than the two following; terminal setæ longer than the antenna itself. Natatory branch of the inferior antennæ (exclusive of the setæ) about equal in length to the basal portion; first joint longer than the two following, second about half the length of the third, which is nearly as long as the remaining six; first joint of the secondary branch short and stout; second long, slender, slightly curved, about equal in length to the first joint of the natatory branch, bearing three setæ at the middle of the external margin; last joint shorter, very slender, and much curved, unguiculate, dilated at the base, apex obtuse. Third joint of the mandibular foot scarcely half the length of the second, bearing a dense brush of plumose setæ on the anterior margin. Third pair of jaws terminating in a broadly triangular trifid lobe, densely clothed with plumose setæ. "Oviferous foot" terminated on one side by a rounded elevation, on the other by a curved claw-like process; setæ very slender, minutely and symmetrically spinous at the apices. Postabdominal laminæ armed with about eleven curved

spines, the last two very long and subequal, fourth and sixth about half the length of the second; third, fifth, seventh, and all the rest very slender and short. Eyes black.

Length $\frac{1}{16}$ in.

Hab. Taken abundantly in the towing-net at Cumbrae, chiefly at night time (*Mr. D. Robertson*); Northumberland coast, Shetland, Plymouth Sound, and amongst *Zostera*, between tide-marks at Herm (*Rev. A. M. Norman*).

Though the description given above differs in some minor points from that of G. O. Sars, I have no doubt that the species referred to is the same; and, indeed, a British specimen which I forwarded to that author for examination was identified by him with *P. longicornis*. There is much variety in the spinous armature of the posterior margin; in most cases one short spine exists near its lower extremity, and rarely one likewise at the upper angle; not unfrequently they are altogether wanting. I have not been able clearly to make out the structure of the maxillary apparatus, nor have I seen any males recognizable as such.

The figure and description given by Mr. Norman (*loc. cit.*) are certainly referable to this species, though, owing to their being taken from worn specimens, they are not quite applicable to the species when seen in good condition. There can, I think, be little doubt that Dr. Baird's description and figures of "*Cypridina interpuncta*" are properly to be identified with *P. longicornis*, Lilljeborg.

Genus 2. Cylindroleberis, Brady*.

Shell elongated fusiform or subcylindrical; beak rounded, not at all produced; upper antennæ of the *male* bearing at the apex two excessively long, annulated, plumose setæ, four shorter setæ, and a short curved claw; penultimate joint bearing at its apex a stout densely ciliated seta; upper antenna of the *female* terminated by a stout curved claw, and six or seven subequal plumose setæ, which do not exceed in length that of the last four joints of the antennæ; penultimate joint bearing at the apex a short seta or pedicle, from the extremity of which spring six long simple setæ. Second joint of the natatory branch of the lower antennæ in the *male* elongated, in the *female* scarcely longer than the succeeding joints; secondary branch in the *male* robust, subchelate, terminal joint slender, curved upwards; in the *female* simple, triarticulate, last joint setiform. Antepenultimate joint of the mandibular foot shorter than the following joint, bearing three long subequal curved setæ, two of which are plumose; penultimate joint armed with five stout setæ on the anterior, and two at the apex of the posterior margin; last joint very short, armed with a curved claw and several setæ. First maxilla consisting of a broad subquadrate or crescentic lamina, densely clothed on its distal margin with long bristles; second maxilla swollen at the base, suddenly narrowed towards the apex, the apical portion bearing six plumose setæ, three of moderate length, and three short, basal portion having a series of ten simple spine-like setæ on its convex margin; third jaw narrow, elongated, set along the whole of the inner margin with short simple setæ, which increase in length towards the apex; oviferous foot terminating in two symmetrical dentate lips, and bearing about six pairs of spinous setæ.

* Intellectual Observer, vol. xii. p. 127.

I have not succeeded in detecting the sexual organs of the two species belonging to this genus; but it seems pretty certain that the forms referred to in the generic description are really the two sexes of one and the same species. The shells of the two forms present no appreciable difference; and the several pairs of jaws, the mandibular and "oviferous" feet, and the postabdominal laminæ are in both precisely alike.

1. Cylindroleberis Mariæ (Baird). (Plate XXXIII. figs. 18–22, and Plate XLI. fig. 1.)

Cypridina Mariæ, Baird, Proceedings Zool. Soc. Lond. part xviii. (1850) p. 257, pl. xvii. (Annulosa) figs. 5–7.

Carapace, as seen from the side, oblong-elliptical, more than twice as long as high, rather higher in front than behind. Dorsal and ventral margins nearly straight, subparallel; beak erect; notch wide, almost rectangular. Extremities obtusely rounded, the posterior rather narrowed. Outline, as seen from above, oblong, subclavate, about twice as long as broad, greatest width in front of the middle; extremities rounded, the anterior deeply cleft in the centre. Notch radiated, produced along the median lines of the dorsal and ventral aspects as well as laterally. End view nearly circular. Muscle-spots very numerous, forming a conspicuous patch near the centre of the valves. Shell pellucid, and showing through it the deep-yellowish-brown body of the animal; growing altogether opaque with age. Eyes black and plainly visible through the shell, rather behind and above the centre. Upper antennæ of the *male* altogether more slender and less densely setose than in the *female*; auditory seta short and stout, dilated and obliquely truncate at the apex; terminal claw also short and stout, scarcely half the length of the adjacent setæ. Second joint of the natatory branch of the lower antennæ in the *female* short, scarcely longer than the following joints; in the *male* nearly as long as the first joint. First pair of maxillæ subquadrate, bearing a large branchial appendage. Oviferous foot terminating in two equal numerously dentate lips; setæ robust, rather irregularly spined toward the apices. Postabdominal laminæ broad, subquadrangular, obliquely truncate behind, armed with six slender marginally dentate, slightly curved claws, which decrease regularly in length from below upwards.

Length $\frac{1}{11}$ in.

Hab. Isle of Skye (*Dr. Baird*); Shetland, Penzance, and with the preceding species in tide-pools at Herm (*Rev. A. M. Norman*); taken in the towing-net at Cumbrae (*Mr. D. Robertson*).

C. Mariæ, though mostly taken in company with *Philomedes longicornis*, is a much scarcer species, the specimens taken at any one time being never very many.

2. Cylindroleberis teres (Norman). (Plate XXXIII. figs. 6–9, and Plate XLI. fig. 2.)

Cypridina teres, Norman, Ann. & Mag. Nat. Hist. vol. viii. (Oct. 1861) pl. xiv. fig. 10.

Carapace of the *female*, as seen from the side, ovate, highest behind the middle; greatest height equal to more than two-thirds of the length; extremities rounded, anterior narrowed, posterior broad; superior and inferior margins evenly convex; notch very narrow, curved. Outline, as seen from above, ovate, widest in the middle, more

than twice as long as broad. Surface of the shell smooth, pellucid, and finely punctate, the brown body of the animal shining through. Terminal claw of the upper antennæ long, slender, nearly equal in length to the adjacent setæ; auditory seta slender, scarcely dilated at the extremity. First maxilla elongated, the distal extremity curved upwards, slender, and terminating in two setæ, between which and the range of marginal setæ there is a considerable interval. The basal joint of the mandibular foot bears on the anterior margin a series of eight short setæ, the last three or four of which are bifid or trifid at the extremity. Postabdominal laminæ short, subovate, bearing seven or eight long slender claws, the last two being much the longest.

Length $\frac{1}{17}$ in.

Hab. Dredged in 7–20 fathoms at Oban (*Rev. A. M. Norman*); Guernsey (*Mr. J. G. Jeffreys*); taken in the towing-net at Cumbrae (*Mr. D. Robertson*).

Genus 3. Bradycinetus, G. O. Sars.

Shell thicker and more compact in structure than in the preceding genera; notch deep, with setose margins. Upper antennæ six-jointed, the apical setæ nearly equal and of no great length. Natatory branch of the lower antennæ nine-jointed, its setæ short; secondary branch in the female very small and biarticulate, the last joint obtuse, and bearing at the apex a curved seta; in the male larger, three-jointed; the last joint long and membranaceous, terminating in two short setæ. Mandibular feet similar to those of the preceding genera, but armed also with a bifurcate mandibular process, in front of which are three toothed spines. First pair of jaws strongly armed with spine-like setæ; second pair having a strong mandibuliform appendage composed of two robust toothlike processes. Eyes small, of pale colour, and scarcely visible through the shell. "Animal mostly moving slowly amongst mud, not swimming nimbly like the preceding."

The chief distinguishing characters of this genus are the strong toothed armature of the second pair of jaws, and the peculiar bifurcate process and toothed spines of the mandibular palp. The lower antennæ are also more shortly ciliated, and the habits of the animal are, according to Sars, much less active than those of the allied genera. Fischer's *Asterope grœnlandica* belongs to this genus, and is either identical with, or closely allied to, *B. brenda*.

1. Bradycinetus brenda (Baird). (Plate XXXIII. figs. 1–5, and Plate XLI. fig. 5.)

Cypridina brenda, Baird, Brit. Entom. p. 181, tab. xxiii. figs. 1 *a–g*.

—— *globosa*, Lilljeborg, De Crustaceis ex ord. trib. p. 171, tab. xvii. figs. 2–10, tab. xviii. figs. 1, 2, 3 & 7.

Bradycinetus globosus, G. O. Sars, *loc. cit.* p. 110.

Carapace of the *female*, as seen from the side, rotundo-ovate; greatest height in the middle, and equal to about three-fourths of the length. Upper margin slightly arched, sloping steeply in front, inferior well and evenly arched, posterior obliquely subtruncate, anterior somewhat narrowed, prominent, and obtusely angular above the notch, which is large and wide, its inferior angle produced into a short tooth. Outline, as seen from

above, subovate, widest in the middle; greatest width equal to a little more than half the length. End view ovate, width equal to three-fourths of the height. Notch, as seen from below, elliptical, seen from the front arcuate. Shell covered densely with short pubescent hairs; colour yellowish white. Second joint of the upper antennæ about as long as the following four united; secondary branch of the inferior antennæ very small, the last joint elongate-ovate, bearing two setæ on its anterior margin, and one, which is curved upwards, on the truncate extremity. Last joint of the mandibular foot armed with three claws, the anterior of which is short, the other two subequal, and nearly twice as long; second joint bearing at its apex a large subconical process, which is armed at the extremity with two moderately long plumose setæ; oviferous feet bearing about twenty-four apical setæ, each of which has 4–6 series of short teeth; extremity hooked at one side. Postabdominal plates having 8–10 dentate claws. "*Male* similar to the female, but rather smaller, the eyes larger and redder; secondary branch of the lower antennæ three-jointed, last joint elongated, membranaceous, terminating in two short setæ."

Length $\frac{1}{12}$ in.

Hab. Forty or fifty miles off Tynemouth, on a muddy bottom (*Rev. A. M. Norman*); "dredged in from 80 to 90 fathoms sand, 20 miles east of the Noss, in the Shetland Isles" (*R. M'Andrew, Esq.*).

I have not had the opportunity of examining the type specimens of this species; but as I believe Dr. Baird considers them to be identical with *B. globosus*, I have here adopted that view.

The following interesting remarks on this species I translate from Sars's work on the Norwegian Ostracoda. The difference noticed by that author between the two forms (probably male and female) have an important bearing on those which I have myself found in *Cylindroleberis Mariæ*. In the latter species, however, the variation occurs principally in the *upper* antennæ. "On account of its slow movements and inconspicuous colour, this species [*B. globosus*] is somewhat difficult to detect amongst the mud in which it constantly seems to live, and with which its shell is often more or less coated. I have mostly found the setæ of the lower antennæ, as represented in Lilljeborg's figure, very short, decreasing in length towards the apex, and non-plumose; but in one individual, which in other respects agreed with the rest, I found a remarkable variation, the setæ attached to the last five joints being much elongated, and adapted for swimming. My attention was first drawn to this as follows. Among several specimens which I had in a glass of sea-water, I saw, to my surprise, one individual suddenly abandon its slow creeping movement, which, from the structure of the lower antennæ, I had alone thought possible for this genus, and, with a peculiar rolling movement, give a short bound upwards from the bottom of the glass. On examination of the animal, I found that the lower antennæ were armed with long swimming-setæ. On account of this peculiarity, I thought that the specimen might possibly be a male, but did not find this surmise borne out by anatomical examination. I have since found amongst my preserved specimens many individuals thus fitted for swimming, and have convinced myself that those with the short setæ are females. The peculiarity is not one of age merely, for I have found it in both young and old individuals; and I have noticed it also in another species

(*B. Lilljeborgii*). In this single example (which, though I could not satisfactorily detect the copulative organs, I must take for the male) the lower antennæ show another marked peculiarity, the shorter branch being much larger than in the female, and having an elongated membranous terminal joint armed with two short setæ, which is entirely wanting in the female. This is shown in Lilljeborg's figure as well as in Baird's figures of the same organs in *Bradycinetus Macandrei*. In the individuals which show this peculiarity the eye-pigment is also much deeper and of a red colour, whilst in the female it is almost entirely absent."

2. Bradycinetus Macandrei (Baird). (Plate XXXIII. figs. 14–17, and Plate XLI. fig. 4.)

Cypridina Macandrei, Baird, Brit. Entom. p. 179, tab. xxii. figs. 1 *a–g*.

Carapace of the *female*, as seen from the side, subcircular, highest in the middle; greatest height equal to more than three-fourths of the length; superior margin arched, sloping steeply in front, inferior boldly rounded; anterior extremity produced into a prominent beak, in shape much like a bird's head, which projects downwards and forwards, terminating in a sharp point, and bearing also at each side a long curved laterally extended process; subjacent notch deep and rather narrow; posterior extremity subtruncate, bearing at its inferior angle a broad truncated and serrated spine. Outline, as seen from above, ovate, tapering to a point in front, broadly rounded behind, greatest width in the middle, equal to half the length; the two lateral curved processes project conspicuously like horns in front, and the posterior spine forms a broad, deeply emarginate mucro behind; hinge-line flexuous, the left valve overlapping behind. The notch appears broadly heart-shaped or subtriangular when seen from below; from the front it is hidden by the two horn-like processes. Surface of the shell finely punctate, white, with clouded patches. Animal almost exactly like that of *B. brenda*; but the filaments of the lower antennæ are profusely plumose, and the secondary branch consists of two broad joints, each of which has four setæ springing from the middle of the external margin, and one from the apex; that from the apex of the distal joint is long and flexuous.

Length $\frac{1}{12}$ in., height $\frac{1}{15}$ in.

Hab. Dredged in 70 fathoms, between the Islands of Lewis and Skye, *R. M'Andrew, Esq.* (*Dr. Baird*); Oban, in mud, and at Cumbrae, amongst the fibres of *Lima hians* (*Mr. D. Robertson*).

Fam. 2. Conchœciadæ.

"Shell very thin and flexible, neither horny nor calcareous, but almost membranaceous, more or less distinctly notched and emarginate in front, forming an orifice through which, as in the preceding family, the lower antennæ are protruded whilst swimming. No eyes. Upper antennæ, in the *female*, small, obscurely jointed, bearing at the apex a brush of auditory filaments, in the *male* much larger and distinctly jointed; between the antennæ is a very large tentacle directed forwards and dilated at the apex. Lower antennæ almost like those of *Cypridina*; basal joint large and stout, natatory branch

bearing long plumose setæ, secondary branch short and, in the male, prehensile. Mandibles distinct, narrow, dentate at the apex : palp large, pediform, geniculate, four-jointed; basal joint very large, produced at the base into a dentate process which stretches beyond the apex of the mandible, last joint armed with elongated claws. Two pairs of jaws; first pair composed of three lobes, the external lobe or palp large, biarticulate, and incurved; second pair provided with a small branchial plate and an elongated subpediform palp. Two pairs of feet; first pair elongated, five-jointed, bearing at the base, like the second maxillæ, a small branchial plate, dissimilar in the male and female; second pair very small and rudimentary. Postabdomen forming two short clawed laminæ."

I have had no opportunity of properly examining any of the animals belonging to this family; and, indeed, its sole claim to admission here rests at present on a single individual taken in Shetland by the Rev. A. M. Norman. The definition given above is taken from the work of G. O. Sars, who describes three species of *Conchœcia*, which appear to be not uncommon on the Norwegian coast, where they are met with either in great depths of water (100–300 fathoms) or swimming near the surface in the open sea.

Genus Conchœcia, Dana.

"Valves elongated, produced in front into a beaked process; shell finely reticulated or marked with concentric striæ; very slightly pilose. Dorsal surface of the carapace flattened in front, sometimes slightly excavated and keeled. Upper antennæ in the female small, scarcely protruding beyond the shell, immobile, obscurely articulated, bearing at the apex four large auditory cilia and a seta twice as large, curved upwards and finely denticulated; in the male much larger, distinctly four-jointed and moveable, some of the apical setæ much elongated, and differing in structure from those of the female. Lower antennæ very powerful, basal portion elongate-triangular, and nearly equalling half the length of the shell; natatory branch seven- to eight-jointed; first joint longer than the rest united, secondary branch biarticulate, first joint much dilated, last very small, bearing, in the female, several subequal setæ, in the male a short hook-like claw. Labrum large, produced like a hood. Mandibles armed at the lower extremity with a strong tooth and a semicircular, flexuous, and finely toothed crest: palp robust, scarcely projecting beyond the valves; basal joint bearing near the apex, in lieu of a branchial appendage, a densely ciliated seta; last joint obliquely truncate, armed with two long and finely toothed claws or spines. First pair of jaws composed of two strongly spined incisive lobes and a large palp, the first joint of which is subovate, and set with long setæ on the anterior and posterior margins; the last small, incurved, armed with several curved claws, which increase in length inwardly. Incisive part of the second pair of jaws scarcely lobed, strongly spined at the apex; branchial lamina small, three-lobed; palp elongated and directed forwards, three-jointed, last joint very small and armed with three unequal claws. First pair of feet five-jointed, bearing at the base a three-lobed branchial plate as in the second pair of jaws; in the female narrow, directed forwards, and armed at the extremity with three elongated claws; in the male much stronger and stretched backwards, terminated by three very long ciliated setæ, which are curved

upwards and backwards. Last pair of feet very small, obsoletely biarticulate, terminating in two unequal setæ, one of which is very long, often exceeding the length of the limb. Abdomen large and stout, in the adult female mostly filled with ova, behind forming an obtuse process. Postabdominal laminæ short and rounded, armed with several claws and one longer annulated seta springing in front. Eyes wanting, but in the base of the upper antennæ are several lens-like bodies which seem to be imperfect organs of vision, irregularly grouped, but always placed in a distinct nervous layer, and without pigment. One male copulative organ, of simple structure, attached in front of the postabdominal plates on the left side. Animal very agile, swimming very rapidly."

? Conchœcia obtusata, G. O. Sars. (Plate XLI. fig. 9.)

Conchœcia obtusata, G. O. Sars, *loc. cit.* p. 118.

Carapace, as seen from the side, subquadrangular, height equal to more than half the length. Anterior margin produced into a sort of hood; posterior obtusely truncate, its inferior angle broadly rounded and destitute of spines; superior and inferior margins nearly straight, parallel. Shell structureless, destitute of striæ or reticulation.

Length $\frac{1}{20}$ in.

Hab. Shetland (*Rev. A. M. Norman*).

The description here given does not accurately correspond with that of *C. obtusata* as given by Sars, particularly as regards the structure of the shell, which that author states to be "striis concentricis subtiliter striata;" but it is impossible to make a minute examination without the destruction of the single specimen preserved in Mr. Norman's collection; I therefore, for the present, refer it to *C. obtusata*, which it approaches, at all events, more closely than any other species.

Section III. CLADOCOPA.

Fam. Polycopidæ.

"Valves subequal, thin, not notched in front. Upper and lower antennæ both natatory, terminated by long setæ, basal portion of both large, stout, and muscular; the upper simple, not geniculate, the lower two-branched, both branches natatory. Mandibles distinct, strongly toothed below; palp short, neither pediform nor clawed. Two pairs only of posterior limbs, scarcely pediform, the first natatory, the second branchial. Abdomen terminated by two short unguiferous laminæ. Eyes wanting. No heart. Intestine forming a simple sac."

Genus Polycope, G. O. Sars.

"Valves rounded, ventricose, thin, and fragile, corneo-calcareous. Forehead having no tentacle, but in its place two ciliated setæ. Upper antennæ three-jointed, last joint short, terminal setæ long and slender; terminal rami of the lower antennæ unequal, one many-jointed, of structure very similar to that of *Cypridina*, the other shorter and three-jointed. Lower extremity of mandibles strongly inflexed, armed with a few small acute

teeth; palp biarticulate, first joint stout, bearing externally a short, bisetose branchial appendage, last narrow, beset with long plumose setæ. Incisive portion of the first pair of jaws small, forming a simple setiferous lobe; palp very large, four-jointed, two-branched, second joint bearing externally a long, narrow, and obsoletely biarticulate branch, which is terminated by long setæ. Second pair of jaws membranaceous, three-jointed; penultimate joint bearing externally a small branch which terminates in a single seta; furnished at the base with a large branchial plate. Postabdominal plates short, posterior margin shortly digitate and armed between the segments with acuminate claws. Animal swimming actively like the Lynceidæ."

Sars thinks that there are probably several species of this genus, but he has not been able accurately to examine and determine more than one. The two species here described I myself know only from their external characters, the few British specimens hitherto found being apparently empty shells.

1. Polycope orbicularis, G. O. Sars. (Plate XXXV. figs. 53–57.)

Polycope orbicularis, G. O. Sars, *loc. cit.* p. 122.

Shell of the *female*, as seen from the side, subcircular, greatest height in the middle, slightly less than the length; anterior margin slightly narrowed and produced, posterior evenly rounded, superior and inferior margins boldly arched. Outline, as seen from above, ovate, tapering equally to each extremity; greatest width in the middle, equal to more than half the length. Valves finely punctate and divided by fine reticulated ribs into numerous polygonal areolæ. Colour pale yellow, marked with patches ("radiating stripes," Sars) of a darker red colour. "Basal joint of the upper antennæ longer than the two others combined, densely hairy on the anterior margin, and provided with a short seta, last joint ending in five long slender setæ; one branch of the lower antennæ eight-jointed, the last seven joints short and subequal; the other three-jointed, first joint longer than the two following combined, bearing eight long partly ciliated setæ. Mandibles divided at the apex into five teeth, the most external of which is much the larger; palp shorter than the mandible itself, its last joint equal in length to the basal joint and bearing seven ciliated setæ. Secondary branch of the anterior maxillæ reaching a little beyond the apex of the palp, and terminating in about eight very long and slender setæ. Branchial plate of the posterior maxillæ narrow, elliptical, bearing sixteen ciliated marginal setæ. Postabdominal plates armed with six finely ciliated claws decreasing gradually in length backwards; behind them two short setæ. Posterior margin of the abdomen bearing three brushes of short hairs. Male unknown."

Length $\frac{1}{85}$ in.

Hab. Shetland and the Minch (*Rev. A. M. Norman*); in oyster-ooze from Stranraer (*G. S. B.*); in shell-sand, Roundstone (*Dr. Alcock*).

There seems to be much difference in the amount of sculpturing of different specimens of *P. orbicularis*. In adults the shell is often almost perfectly smooth, though mostly bearing an obscure reticulated pattern; a single valve from shell-sand at Roundstone (represented at figs. 56 & 57) is more distinctly sculptured than any other specimen that I have seen. Young specimens are punctate but not reticulated.

Probably this is not an uncommon genus; but the extreme minuteness of the animal renders it very liable to be overlooked.

For the anatomical description given above I am indebted to G. O. Sars's work. The same author remarks that the motions of the animal much resemble those of some species of *Chydorus*; it is exceedingly active, having no less than ten limbs adapted for swimming.

2. Polycope (?) dentata, n. sp. (Plate XXXV. figs. 58–59.)

Carapace, as seen from the side, subcircular, highest in the middle; greatest height equal to fully three-fourths of the length. Anterior margin notched above the middle, notch broad and shallow; inferior obliquely arched, more convex in front than behind; superior margin of the *left* valve simply and obliquely arched, the convexity being greatest behind, that of the *right* valve surrounded by a narrow fillet produced in front into two large, broad, and bluntly pointed teeth which are directed forwards, behind which it is at intervals obtusely angulated, so as to form four sides of a polygon, and ends suddenly in a slightly exserted angular tooth above the middle of the posterior margin. Outline, as seen from above, compressed ovate; sulcate along the hinge-line. Shell thin and fragile; surface closely, minutely, and uniformly punctate; colour yellowish. Animal unknown.

Length $\frac{1}{55}$ in.

Hab. Shetland (*Rev. A. M. Norman*).

It may perhaps be doubtful whether this very remarkable and beautiful little species is rightly referred to the genus *Polycope*: it is at any rate very nearly allied to that genus; but as one specimen only has been found, the anatomical details of the animal cannot at present be investigated.

Section IV. PLATYCOPA.

Fam. Cytherellidæ.

"Valves unequal, very thick and calcareous, not notched in front. Antennæ very large, the upper many-jointed and geniculate at the base; lower broad and flattened, two-branched, like the feet of the Copepoda. Mandibles very small, with a large pectinato-setose palp. Three pairs of hinder limbs, scarcely pediform; the two anterior pairs branchial, the others rudimentary. Abdomen terminating in two very small, narrow, and spiniferous laminæ. Ova and embryos borne beneath the shell of the female."

Genus Cytherella, Bosquet.

"Valves elongated, flattened, thick, and hard, very unequal; the right much larger than the left, and overlapping throughout the whole circumference, presenting round the entire inner margin a distinct groove into which the valve of the opposite side is received. Upper antennæ very large, shortly setose or spiniferous, seven-jointed, the

first two joints larger than the rest, and forming between them a distinct geniculation; lower antennæ composed of a large, broad, biarticulate, and geniculate basal portion, from which arise two flattened unequal branches, one biarticulate, the other triarticulate, both beset with very numerous long setæ. Labrum large, subglobose, giving out in front a short subtriangular process. Mandibles very weak, strongly inflexed at the lower extremity, which is obliquely truncate and set in a pectinate manner with slender teeth; palp large and elongate, almost straight, bearing on the inner side very numerous long pectinately arranged setæ, which stretch backwards as in the feet of the Sididæ. First pair of jaws bearing at the base a very large branchial plate, which is beset with numerous ciliated marginal setæ; incisive portion divided into three setiferous lobes; palp very large, scarcely articulated; the posterior margin slightly lobated; the inner margin pectinately setose, like the mandibular palp, but smaller. Second pair of jaws membranaceous, bearing, like the preceding pair, a branchial plate, but smaller and narrower; distal portion subovate, beset with a few ciliated setæ, and in the male furnished with a very large and strong hatchet-shaped appendage adapted for prehension. Third pair of jaws, in the female, rudimentary, forming a simple setiferous lobe; in the male strong, distinctly jointed and subcheliform. Abdomen beset behind with several bundles of long setæ for supporting the ova. Postabdominal laminæ narrow, slightly dilated at the apex, and armed before and behind with several marginal setæ or spines. Copulative organs of the male very large and narrow."

From this definition of the genus it will be seen that it differs very remarkably from all hitherto known forms, presenting, in the conformation of the lower antennæ, a remarkable approach to the Copepoda, and in the palps of the mandibles and first pair of jaws a likeness to the Sididæ. The way in which the animal uses its powerful limbs is not known, it never having been observed in the living state.

1. Cytherella scotica, Brady. (Plate XXXIV. figs. 18–21.)

Cytherella Scotica, Brady, Brit. Assoc. Report, 1866, p. 211.

Valves, as seen from the side, rather obliquely subelliptical, almost equal in height throughout; greatest height equal to more than half the length; extremities broadly, the posterior obliquely rounded, superior and inferior margins slightly concave in the middle. Outline, as seen from above, subconical, subtruncate behind, obtusely pointed and slightly emarginate in front; greatest width situated near the posterior extremity and equal to rather less than half the length, lateral margins nearly straight and converging gently towards the front; hinge-line slightly flexuous near the front, and sulcate. Surface of the shell smooth, faintly punctate, more especially towards the posterior extremity. Colour whitish, opaque. Animal unknown.

Length $\frac{1}{30}$ in.

Hab. The Minch (*Mr. Jeffreys's dredgings*), 60 fathoms.

Two or three specimens only of this interesting species have occurred to the Rev. A. M. Norman and myself, amongst sand dredged off the Scotch coast by Mr. Jeffreys. It is very nearly allied to *Cytherella abyssorum*, Sars; and, indeed, until I saw specimens

of the latter species, I considered the two to be identical. But a comparison with Norwegian specimens, kindly communicated by Herr G. O. Sars, leads me to believe them distinct. The characters in which *C. abyssorum* chiefly differs from the present species are as follows:—The extremities, especially the anterior, as seen from above, are more abruptly truncate, the angles somewhat produced, and the general outline more compressed; seen from the side, the outline is more evenly elliptical; the surface of the shell is much more profusely punctate and the puncta larger.

2. Cytherella lævis, Brady. (Plate XXXIV. figs. 15–17.)

Cytherella lævis, Brady, Brit. Assoc. Report, 1866, p. 211.

Valves, as seen from the side, subovate, highest in front, greatest height equal to about three-fourths of the length; anterior extremity broadly rounded, posterior rather narrowed; superior margin well arched, sloping steeply behind; inferior sinuated in the middle. Outline, as seen from above, ovate; sides and angles well rounded. Surface quite smooth and devoid of sculpture. Colour yellowish white.

Length $\frac{1}{37}$ in.

Hab. The Minch, 60 fathoms.

One valve only was found, in the same gathering as the previous species.

APPENDIX.

The following species were, for various reasons, not noticed in the foregoing pages:—

Bairdia fulva, nov. sp. (Plate XXVIII. fig. 21.)

Carapace, as seen from the side, subreniform, highest in front of the middle; greatest height equal to rather more than half the length; anterior extremity rounded; posterior somewhat narrowed, rounded below; superior margin boldly arched, inferior sinuated in the middle. Seen from above, compressed ovate, widest in the middle; extremities equally acuminate; width much less than half the length. The right valve is much larger and higher than the left, and overlaps considerably, both on the dorsal and ventral margins; it is also much less angular in outline. Surface of the shell finely and closely punctate. Colour yellowish brown. Animal unknown.

Length $\frac{1}{35}$ in.

My first acquaintance with this species was derived from a single valve of the left side found among shell-sand from Roundstone. From its shape and the characters of its surface-marking, I supposed that it might perhaps be referable to a variety of, or to some species nearly allied to, *Cytheridea punctillata*, and I therefore figured the valve in juxtaposition with that species. But having more recently seen a perfect specimen, found by Mr. Robertson at Shetland, as well as one or two fossil examples, I have no hesitation in describing it as an entirely new species of *Bairdia*. It will be fully illustrated in the 'Monograph of Posttertiary Entomostraca.'

CYTHERE EMARGINATA (G. O. Sars).

Cythereis emarginata, G. O. Sars, *loc. cit.* p. 38.

Scandinavian type. DISTRIBUTION: *Recent*—Baffin's Bay, Norway, Shetland. *Fossil*—Glacial, Scotland, Norway.

Shell of the *female*, seen from the side, subreniform, highest near the middle; greatest height much more than half the length. Anterior extremity rounded, posterior produced below the middle into a prominent angular lobe; superior margin boldly arched, inferior sinuated in front of the middle and bending upwards behind. Seen from above, the shell is compressed ovate; extremities broadly mucronate. Right valve very different from the left, higher and more boldly arched, sinuated in front of the eyes; posterior extremity more deeply emarginate and more prominent below. Shell of the *male* distinctly quadrangular; greatest height scarcely exceeding half the length, and situated near the front; superior margin only slightly armed; posterior obliquely truncate. Surface irregularly sculptured with large angular excavations; the sculptured portion of the shell terminating abruptly in a transverse ridge, a little in front of the posterior extremity, and below in a sharply cut ventral rib, which is most conspicuous posteriorly. Hinge-line marked on the dorsal aspect by a deep sulcus; hinge-teeth large and strong.

Length $\frac{1}{30}$ in.

Dredged by Mr. D. Robertson off Shetland. The only British species with which *C. emarginata* can be confounded is *C. angulata*, which, however, is considerably smaller and may mostly be distinguished also by the absence of any sharply cut transverse declivity, the prominent tuberculation of the valves, and often by a more or less radiate arrangement of the surface-sculpture. *C. costata*, Brady, an Arctic species, is a much nearer relative.

EUCYTHERE ANGLICA, nov. sp. (Plate XXV. figs. 49, 50.)

Carapace, seen from the side, subtriangular, highest in the middle, greatest height equal to nearly two-thirds of the length; anterior extremity broadly rounded, posterior narrowed, obliquely rounded; superior margin very strongly arched, sloping steeply behind, inferior almost straight. Seen from above, the outline is compressed ovate, widest in the middle, tapering to an acute point in front, more obtuse behind, the hinge-line showing a well-defined sulcus behind the middle. Surface of the shell stony in appearance, rudely punctate, and towards the margins showing traces of concentric furrows.

Length $\frac{1}{50}$ in.

Hab. Dredged off the Durham coast (*G. S. B.*), and off the Morecambe Light-ship (*Mr. D. Robertson*).

This is referred to, under my description of *E. declivis*, as a small, roughly punctate form of that species. Having only met with two specimens in a single locality, I hesitated to admit it as a distinct species; but Mr. Robertson has recently sent me three specimens, completely identical with it, from the west coast, and I think there can be no longer any doubt respecting the propriety of assigning to them a separate specific name.

CYTHEROPTERON RECTUM, nov. sp.

Carapace, as seen from the side, oblong, subquadrangular, nearly equal in height throughout; height equal to less than half the length; extremities rounded; superior margin straight, terminating abruptly at each extremity in a small protuberance; inferior almost straight; dorsal aspect oblong subovate, widest behind the middle, suddenly constricted at the posterior third; extremities pointed, width rather more than the height. Shell-surface closely and minutely punctate; lateral ala not very prominent, rounded off in front, abruptly angular behind.

Length $\frac{1}{50}$ in.

One specimen only was dredged, by Mr. D. Robertson, in Lerwick Bay, Shetland, in a depth of 12–14 fathoms.

Note on CYTHERE JONESII.

In the Mediterranean, the Bay of Biscay, and on the western coast of Ireland, a form which appears to me to be properly referable to this species, but at the same time remarkably different in some minor characters, is abundantly met with. The points in which it differs are, the much greater delicacy and transparency of the shell, and the greater length and slenderness of the entire spinous armature. In the position of the spines and the general outline of the shell, it does not differ appreciably from the typical form of the species. I have no hesitation in identifying it with the *Cythereis ceratoptera* of Bosquet, and, I think, also with the *C. subcoronata* of Speyer. The figures given by the latter author seem, indeed, to be widely different, but a specimen which he kindly communicated to me is either identical, or very nearly so, with the form here noticed.

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TABLE illustrating the Distribution of the British Marine Ostracoda.

"Littoral" includes everything between tide-marks and in salt-marshes; "deep-water" everything beyond low-water mark, also shell-sand. *** indicates the prevailing forms in each district. ** indicates moderately common species. * indicates rare species.

NAME OF SPECIES.	Channel Islands.		S.W. ENGLAND. (Devon, Cornwall, and South Wales.)		Galway and West Ireland.		S.W. SCOTLAND. (Clyde district, Isle of Man, North Wales.)		N.W. SCOTLAND. (Skye, Hebrides, &c.)		N. SCOTLAND. (Orkney, Sutherland, &c.)		Shetland.		E. SCOTLAND. (Aberdeenshire &c.)		N.E. ENGLAND. (Northumberland, Durham, Yorkshire, and Dogger Bank.)		S.E. ENGLAND. (Norfolk, Thames, &c.)		Norway.	Post-tertiary Fossils.
	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water		
PARACYPRIS																						
polita, *Sars*	..	**	..	..	..	..	..	..	..	**	..	..	..	**	..	..	..	..	..	..	**	*
PONTOCYPRIS																						
mytiloides, *Norman*	..	**	..	**	..	**	..	**	..	**	..	..	..	*	..	*	..	*	..	..	**	*
acupunctata, *Brady*	..	..	..	..	..	*	..	..	..	*												
trigonella, *Sars*	*	*	..	*	..	*	*	**	..	..	..	..	..	..	..	..	..	..	..	*	**	*
angusta, *Brady*	..	..	..	..	..	*																
BAIRDIA																						
inflata, *Norman*	..	*	..	*	..	**	..	**	..	*	..	*	..	*	..	..	..	..	..	..	..	*
acanthigera, *Brady*	..	*	..	**																		
obtusata, *Sars*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	.	..	..	..	..	..	*	
complanata, *Brady*	..	..	..	..	..	..	..	..	..	*												
fulva, *Brady*	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
MACROCYPRIS																						
minna, *Baird*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	**	
CYTHERE																						
lutea, *Müller*	*	..	..	..	..	*	**	**	..	**	..	**	**	..	..	..	***	..	**	..	***	*
viridis, *Müller*	**	*	..	..	..	***	*	**	..	**	..	..	..	..	..	*	..	..	*	..	**	*
pellucida, *Baird*	*	**	**	**	..	**	*	**	..	**	..	**	..	**	..	**	**	**	..	***	**	*
castanea, *Sars*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	***	..	***	..	**	
tenera, *Brady*	..	..	..	..	..	..	..	*	..	**	..	..	..	*	..	..	..	*	..	**	**	*
badia, *Norman*	*	..	*	..	..	*	*	*	*	*	..	..	..	..	..	..	..	..	..	..	*	*
oblonga, *Brady*	..	..	*																			
rubida, *Brady*	..	..	..	..	..	..	*															
albo-maculata, *Baird*	***	**	***	**	**	***	***	**	**	**	..	..	**	*	..	*	***	..	**	***	*	*
convexa, *Baird*	*	**	..	*	..	***	*	**	..	**	..	..	..	*	..	..	..	..	..	..	..	*
cuneiformis, *Brady*	..	*	..	..	..	*	..	*	..	*	..	..	..	..	..	..	..	*	..	..	*	*
limicola, *Norman*	..	..	..	..	..	..	..	*	..	*	..	..	..	..	..	*	..	*	..	..	*	*
globulifera, *Brady*	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
tuberculata, *Sars*	..	**	..	**	..	**	..	**	..	**	..	**	..	**	..	**	..	**	..	**	**	*
concinna, *Jones*	..	..	..	..	..	*	..	*	..	**	..	*	..	..	..	..	..	*	..	..	**	*
angulata, *Sars*	..	..	..	..	..	..	..	*	..	*	..	*	..	*	..	*	..	..	..	..	*	
emarginata, *Sars*	..	..	..	..	..	..	..	..	..	..	..	..	..	*								
dubia, *Brady*	..	..	..	..	..	..	..	..	..	..	..	..	..	*								
finmarchica, *Sars*	*	*	..	*	..	*	..	*	..	*	..	..	..	..	..	..	..	..	..	*	**	*
pulchella, *Brady*	..	..	..	..	..	..	..	..	..	..	..	*										
villosa, *Sars*	*	**	..	**	..	**	*	***	**	***	..	**	..	*	..	*	..	*	*	..	**	*
semipunctata, *Brady*	..	..	..	..	..	*																
Jeffreysii, *Brady*	..	*	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
laticarina, *Brady*	..	*	..	..	..	..	..	*														
marginata, *Norman*	..	..	..	..	..	..	*															
quadridentata, *Baird*	..	..	..	..	..	..	..	*	..	**	..	..	..	*	..	..	..	*	..	..	..	*
emaciata, *Brady*	..	..	..	**	..	**	..	..	..	*	..	..	..	*	..	*	..	*	..	..	..	*
mirabilis, *Brady*	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	*
dunelmensis, *Norman*	..	..	..	..	..	*	..	**	..	*	..	..	..	..	..	..	..	*	..	..	**	
mucronata, *Sars*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	*	*
Whiteii, *Baird*	..	..	..	*	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	*
antiquata, *Baird*	..	..	..	*	..	**	..	**	..	*	..	..	..	*	..	*	..	..	..	..	*	*
Jonesii, *Baird*	..	..	..	..	..	*	..	*	..	*	..	*	..	*	..	*	..	*	..	..	*	
acerosa, *Brady*	..	..	..	*																		
CYTHERIDEA																						
elongata, *Brady*	..	**	..	***	..	**	..	*	..	*	..	..	..	..	..	**	*	..	..	***	..	*
papillosa, *Bosquet*	..	..	..	..	..	..	..	**	..	**	..	..	..	..	..	*	..	**	..	*	**	*
punctillata, *Brady*	..	..	..	..	..	..	..	*	..	**	..	..	..	*	..	..	..	..	..	*	**	
zetlandica, *Brady*	..	..	..	..	..	..	..	..	..	..	..	..	..	*								
subflavescens, *Brady*	..	..	..	..	..	..	..	..	..	*												
torosa, *Jones*	*	..	**	..	..	..	..	..	..	..	..	..	..	..	..	..	***	..	**	..	***	
Sorbyana, *Jones*	..	..	..	..	..	..	..	*	..	*	..	..	..	..	..	..	..	..	..	..	*	*
EUCYTHERE																						
declivis, *Norman*	..	*	..	**	..	**	..	..	..	*	..	..	..	**	..	*	..	*	..	*	*	*
Argus, *Sars*	..	..	..	..	..	*	..	..	..	..	*	..	..	..	..	..	..	*	..	*	*	
anglica, *Brady*	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*				
ILYOBATES																						
bartonensis, *Jones*	..	..	..	..	..	..	..	*	..	*	..	..	..	*	..	..	..	*	..	..	**	
LOXOCONCHA																						
impressa, *Baird*	***	***	..	***	**	***	**	***	..	**	..	..	..	*	..	..	*	..	..	**	**	*

TABLE (*continued*).

NAME OF SPECIES.	Channel Islands.		S.W. ENGLAND. (Devon, Cornwall, and South Wales.)		Galway and West Ireland.		S.W. SCOTLAND. (Clyde district, Isle of Man, North Wales.)		N.W. SCOTLAND. (Skye, Hebrides, &c.)		N. SCOTLAND. (Orkney, Sutherland, &c.)		Shetland.		E. SCOTLAND. (Aberdeenshire &c.)		N.E. ENGLAND. (Northumberland, Durham, Yorkshire, and Dogger Bank.)		S.E. ENGLAND. (Norfolk, Thames, &c.)		Norway.	Post-Tertiary Fossils.
	Littoral	Deep water	Littoral	Deep water	Littoral.	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water	Littoral	Deep water		
LOXOCONCHA																						
granulata, *Sars*	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	.	..	**	
elliptica, *Brady*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*			
tamarindus, *Jones*	*	***	..	***	..	***	..	**	..	**	..	..	..	**	..	**	*	**	..	**	*	*
guttata, *Norman*	..	..	..	*	..	**	..	*	..	**	..	..	..	..	..	**	..	**	..	*	..	*
XESTOLEBERIS																						
aurantia, *Baird*	**	..	**	..	**	**	*	..	..	..	..	..	..	..	*	*	*	..	*	..	**	*
depressa, *Sars*	..	**	..	**	..	***	..	**	..	**	..	..	..	**	..	**	..	**	..	.	**	*
CYTHERURA																						
nigrescens, *Baird*	**	..	..	*	**	**	**	**	..	*	..	*	..	**	..	..	*	..	..	..	***	*
angulata, *Brady*	..	..	..	*	..	*	*	..	..	*	..	..	..	*	..	*	..	..	..	.	.	*
striata, *Sars*	*	..	..	**	..	**	..	*	..	**	..	..	..	*	..	..	..	*	..	*	*	*
lineata, *Brady*	..	..	..	..	..	..	..	..	..	*												
cuneata, *Brady*	*	..	..	*	..	**	..	..	..	*	..	*	..	*	..	*						
Sarsii, *Brady*	..	..	..	..	..	..	..	*														
similis, *Sars*	..	..	..	..	..	..	..	*	..	..	..	..	..	*	..	..	..	..	..	.	*	*
undata, *Sars*	..	..	..	..	..	**	*	**	..	**	..	..	..	**	..	*	..	..	..	..	**	
producta, *Brady*	..	..	..	..	..	*	..	*	..	*												
affinis, *Sars*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	*	..	*	..	.	*	
Robertsoni, *Brady*	..	..	..	..	..	..	*	*														
gibba, *Müller*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		*	
cornuta, *Brady*	..	..	..	..	..	*	..	*	..	..	..	*										
acuticostata, *Sars*	*	..	..	**	..	***	*	**	..	*	..	..	..	*	..	*	..	*				
clathrata, *Sars*	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	*	*	*
cellulosa, *Norman*	..	*	..	..	..	**	*	*	..	..	..	..	..	*	..	..	..	*				
CYTHEROPTERON																						
subcircinatum, *Sars*	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*	
latissimum, *Norman*	..	..	..	*	..	..	..	**	..	..	..	..	..	**	..	**	..	**	..	**	**	*
nodosum, *Brady*	..	..	..	..	..	**	..	..	..	*	..	..	..	..	..	..	..	..	..	.	.	*
punctatum, *Brady*	..	..	..	..	..	..	..	*	..	*												
multiforum, *Norman*	..	*	..	*	..	*	..	*	..	**	..	..	..	*	..	*	..	*				
rectum, *Brady*	..	..	..	..	..	..	..	..	..	..	..	..	..	*								
BYTHOCYTHERE																						
simplex, *Norman*	..	..	..	..	..	..	*	*	..	*	..	..	..	*	..	**	..	*	..	.	**	*
constricta, *Sars*	..	**	..	**	..	**	..	*	..	**	..	..	..	*	..	*	..	*			*	
turgida, *Sars*	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*				
PSEUDOCYTHERE																						
caudata, *Sars*	*	..	..	..	..	*	..	..	..	*	..	..	..	..	..	..	..	*	..	..	*	
CYTHERIDEIS																						
subulata, *Brady*	*	*	..	*	..	*	*	*	..	..	..	..	..	..	..	*						
SCLEROCHILUS																						
contortus, *Norman*	..	**	..	**	..	**	*	***	..	**	..	..	..	**	..	**	..	***	..	**	*	*
PARADOXOSTOMA																						
variabile, *Baird*	***	..	**	..	..	..	*	**	..	**	..	..	..	**	..	..	***	..	**	..	***	*
Normani, *Brady*	*	..	..	*	..	..	..	..	..	*	..	..	..	*	..	..	..	..	..	*	*	
abbreviatum, *Sars*	..	..	..	*	..	..	*	**	..	**	..	..	..	*	..	..	..	..	..	..	*	
pulchellum, *Sars*	**	..	..	..	..	..	*	..	*	..	..	..	..	*	..	..	..	..	..	..	*	
obliquum, *Sars*	*	..	..	..	..	**	*	*	..	*	..	..	..	*								
hibernicum, *Brady*	..	..	..	..	*	..	*	..	*													
sarniense, *Brady*	**	..	**																			
ensiforme, *Brady*	*	..	..	*	..	*	..	..	..	*	..	..	..	*	..	*	..	..	..	*		
flexuosum, *Brady*	..	..	..	*	..	*	*	..	..	*	..	..	..	..								
arcuatum, *Brady*	..	..	..	..	..	*																
PHILOMEDES																						
interpuncta, *Baird*	*	..	..	*	..	..	..	**	..	*	..	..	..	*	..	..	..	*		..	**	
CYLINDROLEBERIS																						
Mariæ, *Baird*	*	..	..	*	..	..	..	*	..	*	..	..	..	*								
teres, *Norman*	..	*	..	..	..	..	..	*														
BRADYCINETUS																						
brenda, *Baird*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	*	..		**	
MacAndrei, *Baird*	..	..	..	..	..	..	..	*	..	*												
CONCHŒCIA																						
obtusata, *Sars*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	*	
POLYCOPE																						
orbicularis, *Sars*	..	..	..	..	..	*	..	*	..	*	..	..	..	*	..	..	..	..	..	..	**	
dentata, *Brady*	..	..	..	..	..	..	..	..	..	..	..	..	..	*								
CYTHERELLA																						
scotica, *Brady*	..	..	..	..	..	..	..	..	..	*												
lævis, *Brady*	..	..	..	..	..	..	..	..	..	*												

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angustata, 421.
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arborescens, 401.
areolata, 405.
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carinata, 433.
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cicatricosa, 399.
concinna, 408.
complexa, 405.
contorta, 455.
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debilis, 423.
declivis, 430.
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dunelmensis, 416.
emaciata, 414.
emarginata, 475.
finmarchica, 410.
flavida, 433.
gibba, 444.
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globulifera, 406.
guttata, 436.
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inflata, 388.
inopinata, 419.
Jeffreysii, 412.
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Cythere *lævata*, 435.
laticarina, 412.
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limicola, 405.
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marginata, 413.
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mirabilis, 415.
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mutabilis, 406.
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nigrescens, 440.
nitida, 437.
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rhomboidea, 433.
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? semipunctata, 411.
setosa, 395.
simplex, 450.
subdeltoidea, 388.
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tenera, 399.
tuberculata, 406.
variabilis, 457.
ventricosa, 404.
villosa, 411.
viridis, 397.
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Cythereis angulata, 409.
antiquata, 417.
clavata, 408.
dunelmensis, 416.
emarginata, 475.
fimbriata, 418.
finmarchica, 410.
horrida, 416.
Jonesii, 418.
limicola, 405.
mucronata, 415.
spectabilis, 418.
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Cythereis tuberculata, 406.
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lacustris, 427.
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subflavescens, 429.
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Cytherideis, 454.
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Cytheropteron, 447.
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Cytherura, 439.
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affinis, 443.
angulata, 440.
cellulosa, 446.
clathrata, 446.
cornuta, 445.
cuneata, 442.
gibba, 444.
humilis, 443.
lineata, 441.
nana, 446.
Cytherura nigrescens, 440.
producta, 443.
Robertsoni, 444.
Sarsii, 442.
similis, 442.
striata, 441.
undata, 443.
Eucythere, 429.
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declivis, 430.
Ilyobates, 431.
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Jonesia simplex, 450.
Limnicythere, 419.
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monstrifica, 420.
Loxoconcha, 432.
elliptica, 435.
granulata, 434.
guttata, 436.
impressa, 433.
longipes, 435.
rhomboidea, 433.
tamarindus, 435.
Macrocypris, 391.
minna, 392.
Monoculus aurantius, 363.
candidus, 383.
monachus, 379.
ovum, 373.
ruber, 363.
vidua, 375.
villosus, 377.
virens, 364.
Myodocopa, 462.
Newnhamia, 379.
Notodromas, 379.
monachus, 379.
Paracypris, 377.
polita, 378.
Paradoxostoma, 456.
abbreviatum, 458.
arcuatum, 461.
ensiforme, 460.
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Paradoxostoma Normani, 458.
obliquum, 459.
pulchellum, 459.
sarniense, 460.
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Philomedes, 462.
interpuncta, 463.
longicornis, 463.
Platycopa, 472.
Podocopa, 360.
Polycope, 470.
?dentata, 472.
orbicularis, 471.
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Pontocypris, 384.
acupunctata, 386.
angusta, 387.
mytiloides, 385.
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Pseudocythere, 453.
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Xestoleberis, 437.
aurantia, 437.
depressa, 438.
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EXPLANATION OF THE PLATES.

PLATE XXIII.

Notodromas monachus.

Fig. 1. Carapace (male), seen from left side, × 33.
2. do. do. above, × 33.
3. do. do. below, × 33.
4. do. do. front, × 33.
5. Carapace (female), from left side, × 33.
6. Detached valves of female carapace, seen from below, × 40.
7. Left valve (female), seen from behind, × 40.
8. Postabdominal ramus, × 112.
9. Lucid spots, × 84.

Cypris fusca.

10. Carapace of female, from right side, × 25.
11. do. do. above, × 25.
12. do. do. below, × 25.
13. do. do. front, × 25.
14. Lucid spots, × 80.
15. Postabdominal ramus, × 80.

Cypris incongruens.

16. Carapace of female, from left side, × 20.
17. do. do. above, × 20.
18. do. do. below, × 20.
19. do. do. front, × 20.
20. Postabdominal ramus, × 84.
21. Anterior extremity of right valve, external surface, × 84.
22. A portion of the anterior margin of right valve, seen from within, × 84.

Cypris virens.

Fig. 23. Carapace of female, seen from right side, × 16.
24. Carapace of female, seen from above, × 16.
25. do. do. below, × 16.
26. do. do. front, × 16.
27. Postabdominal ramus, × 80.
28. Hinge-margin, right valve, × 40.
29. do. left valve, × 40.
30. Lucid spots, × 80.
31. Contact margin, left, × 40.
32. do. right, × 40.

Cypris obliqua.

33. Carapace of female, seen from right side, × 25.
34. Carapace of female, seen from above, × 25.
35. do. do. below, × 25.
36. do. do. front, × 25.
37. Postabdominal ramus, × 80.
38. Lucid spots, × 80.

Cypris tessellata.

39. Carapace of female, seen from right side, × 40.
40. Carapace of female, seen from above, × 40.
41. do. do. below, × 40.
42. do. do. front, × 40.
43. Shell-structure, × 310.
44. Postabdominal ramus, 120.
45. Lucid spots, 120.

Plate XXIV.

Cypris compressa.

Fig. 1. Carapace of female, seen from left side, × 40.
2. Carapace of female, seen from above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.
5. Postabdominal ramus, × 190.

Cypris striolata.

6. Carapace of female, seen from left side, × 40.
7. Carapace of female, seen from above, × 40.
8. do. do. below, × 40.
9. do. do. front, × 40.
10. Shell-sculpture, × 310.

Cypridopsis villosa.

11. Carapace of female, seen from left side, × 40.
12. Carapace of female, seen from above, × 40.
13. do. do. below, × 40.
14. do. do. front, × 40.
15. Lucid spots, × 80.

Cypridopsis aculeata.

16. Carapace of female, seen from left side, × 40.
17. Carapace of female, seen from above, × 40.
18. do. do. below, × 40.
19. do. do. front, × 40.
20. Shell-sculpture and spines, × 200.

Cypris lævis.

21. Carapace of female, seen from left side, × 50.
22. Carapace of female, seen from above, × 50.
23. do. do. below, × 50.
24. do. do. front, × 50.
25. Lucid spots, × 80.
26. Postabdominal ramus, × 210.

Variety (Loch of the Lowes).

43. Carapace, seen from left side, × 80.
44. do. do. above, × 80.
45. do. do. below, × 80.

Cypridopsis vidua.

Fig. 27. Carapace of female, seen from left side, × 40.
28. Carapace of female, seen from above, × 40.
29. do. do. below, × 40.
30. do. do. front, × 40.
46. Seta and hyaline vesicle of lower antenna, × 400.

Cypris ovum.

31. Carapace of female, seen from left side, × 40.
32. Carapace of female, seen from above, × 40.
33. do. do. below, × 40.
34. do. do. front, × 40.

Candona detecta.

35. Carapace, seen from right side, × 40.
36. do. do. above, × 40.
37. do. do. below, × 40.
38. do. do. front, × 40.

Cypris cinerea.

39. Carapace of female, seen from left side, × 40.
40. Carapace of female, seen from above, × 40.
41. do. do. below, × 40.
42. do. do. front, × 40.

Cypris gibba.

47. Carapace of female, seen from left side, × 40.
48. Carapace of female, seen from above, × 40.
49. do. do. below, × 40.
50. do. do. front, × 40.
51. Shell-sculpture, × 190.
52. Postabdominal ramus, × 190.
53. Separated valves, showing hinge-margins, × 40.
54. Outline of carapace (tuberculated variety), × 40.

Candona lactea.

55. Carapace of female, seen from left side, × 50.
56. Carapace of female, seen from above, × 50.
57. do. do. below, × 50.
58. do. do. front, × 50.

Plate XXV.

Candona candida.

Fig. 1. Carapace of female, seen from left side, × 40.
2. Carapace of female, seen from above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.
5. Lucid spots, × 96.
6. Outline, young carapace, × 40.
7. do. adult male (Regent's Park), × 40.
8. do. do. (Gravesend), × 40.
9. Structure of posterior extremity of shell (Gravesend), × 210.

Cypris reptans.

10. Carapace of female, seen from left side, × 16.
11. Carapace of female, seen from above, × 16.
12. do. do. below, × 16.
13. do. do. front, × 16.
14. Lucid spots, × 40.

Cypris serrata.

15. Carapace of female, seen from left side, × 25.
16. Carapace of female, seen from above, × 25.
17. do. do. below, × 25.
18. do. do. front, × 25.
19. Lucid spots, × 60.

Candona albicans.

20. Carapace of female, seen from left side, × 50.
21. Carapace of female, seen from above, × 50.
22. do. do. below, × 50.
23. do. do. front, × 50.
24. Lucid spots, × 210.
25. Shell-sculpture, × 210.

Pontocypris serrulata.

26. Carapace (female), seen from left side, × 40.
27. do. do. above, × 40.
28. do. do. below, × 40.
29. do. do. front, × 40.
30. Detached valves, showing hinge-margins, × 40.

Pontocypris trigonella.

Fig. 31. Carapace (female), seen from left side, × 40.
32. do. do. above, × 40.
33. do. do. below, × 40.
34. do. do. front, × 40.

Loxoconcha impressa.

35. Carapace of male, seen from left side, × 40.
36. do. do. above, × 40.
37. do. do. below, × 40.
38. do. do. front, × 40.
39. Lucid spots, × 84.
40. Shell-surface, × 84.
a, original surface, *b*, incrustation.
40*. Carapace of female, seen from left side, × 40.

Cypris trigonella.

41. Carapace of female, seen from left side, × 40.
42. Carapace of female, seen from above, × 40.
43. do. do. below, × 40.
44. do. do. front, × 40.

Loxoconcha tamarindus.

45. Carapace of female, seen from left side, × 40.
46. Carapace of female, seen from above, × 40.
47. do. do. below, × 40.
48. do. do. front, × 40.

Eucythere anglica.

49. Carapace, seen from left side, × 40.
50. do. do. above, × 40.

Loxoconcha granulata.

51. Carapace (male), seen from left side, × 40.
52. do. do. below, 40.

Pontocypris acupunctata.

53. Carapace of female, seen from left side, × 40.
54. Carapace of female, seen from above, × 40.
55. do. do. below, × 40.
56. do. do. front, × 40.

Plate XXVI.

Cypris punctillata.

Fig. 1. Carapace of female, seen from left side, × 16.
2. Carapace of female, seen from above, × 16.
3. do. do. below, × 16.
4. do. do. front, × 16.
5. Lucid spots, × 40.
6. Shell-sculpture, × 100.
7. Postabdominal ramus, × 80.

Cypris salina.

8. Carapace of female, seen from left side, × 40.
9. Carapace of female, seen from above, × 40.
10. do. do. below, × 40.
11. do. do. front, × 40.
12. Lucid spots, × 80.
13. Postabdominal ramus, × 140.

Cypris bispinosa.

14. Carapace of female, seen from left side, × 16.
15. Carapace of female, seen from above, × 16.
16. do. do. below, × 16.
17. do. do. front, × 16.

Cytheridea lacustris.

18. Carapace of female, seen from left side, × 40.
19. Carapace of female, seen from above, × 40.
20. do. do. below, × 40.
21. do. do. front, × 40.

Candona compressa.

22. Carapace of female, seen from left side, × 40.
23. Carapace of female, seen from above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.
26. Reticulation of shell, × 96.
27. Lucid spots, × 96.

Cythere concinna.

28. Carapace (male), seen from left side, × 40.
29. do. do. above, × 40.
30. do. do. below, × 40.
31. do. do. front (Campbeltown Bay), × 40.
32. Carapace (female), seen from left side (the Minch), × 40.
33. Outline of right valve, from above, × 40.

Cythere mucronata.

34. Right valve, seen from side, × 40.
34*a*. do. do. below, × 40.

Cytheridea punctillata.

35. Carapace (male), seen from left side (the Minch), × 40.
36. Carapace (female), seen from left side, × 40.
37. Carapace (female), seen from above (Loch Fyne), × 40.
38. Hinge-margins of right and left valves, × 40.

Cythere angulata.

39. Carapace of female, seen from right side, × 40.
40. Carapace of female, seen from above, × 40.
41. do. do. below, × 40.
42. do. do. front, × 40.

Plate XXVII.

Paracypris polita.

Fig. 1. Carapace, seen from left side, × 40.
2. do. do. above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.

Macrocypris minna.

5. Carapace, seen from left side, × 16.
6. Carapace, seen from above, × 16.
7. do. do. below, × 16.
8. do. do. front, × 16.

Bairdia inflata.

9. Carapace, seen from left side, × 40.
10. do. do. above, × 40.
11. do. do. below, × 40.

Fig. 12. Carapace, seen from front (Lamlash), × 40.
13. Outline of left valve (Channel Islands), × 40.
14–17. Outline of left valve (Roundstone), × 40.

Bairdia acanthigera.

18. Carapace, seen from left side, × 40.
19. do. do. above, × 40.
20. do. do. below, × 40.
21. do. do. front, × 40.

Eucythere declivis.

22. Carapace (female), seen from left side, × 40.
23. do. do. above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.
26. Separated valves, from above, × 40.
52, 53. Variety (?) (Devonshire), × 40.
54, 55. Carapace of male, × 40.

Xestoleberis depressa.

27. Carapace (of female), seen from left side, × 40.
28. Carapace (of female), seen from above, × 40.
29. do. do. below, × 40.
30. do. do. front, × 40.
31. Separated valves, showing hinge-margins, × 40.

Fig. 32. Carapace of male, seen from left side, × 40.
33. do. do. below, × 40.

Xestoleberis aurantia.

34. Carapace of female, seen from left side, × 40.
35. Carapace of male, seen from left side, × 40.
36. do. do. above, × 40.
37. do. do. front, × 40.

Loxoconcha elliptica.

38. Carapace (female), seen from left side, × 40.
39. do. do. above, × 40.
45. Carapace of male, seen from left side, × 40.
46. do. do. above, × 40.
47. do. do. below, × 40.
48. do. do. front, × 40.

Loxoconcha guttata.

40. Carapace (female), seen from left side, × 40.
41. do. do. above, × 40.
42. do. do. below, × 40.
43. do. do. front, × 40.
44. Separated valves, showing hinge-margins, × 40.

Eucythere Argus.

50. Carapace (female), seen from left side, × 40.
51. do. do. above, × 40.
49. Carapace (male?), from left side, × 40.

Plate XXVIII.

Cytheridea papillosa.

Fig. 1. Carapace (female), seen from left side, × 40.
2. do. do. above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.
5. Hinge-margins: (*a*) left, (*b*) right, × 40.
6. Lucid spots, × 84.

Cytheridea torosa.

7. Carapace (female), seen from left side, × 40.
8. do. do. above, × 40.
9. do. do. below, × 40.
10. do. do. front, × 40.
11. Lucid spots, × 84.
12. Hinge-margins: (*a*) left, (*b*) right, × 84.

Cytheridea elongata.

13. Carapace, seen from left side, × 40.

Fig. 14. Carapace, seen from above, × 40.
15. do. do. below, × 40.
16. do. do. front, × 40.

Cytheridea punctillata.

17. Carapace (female), seen from left side, × 40.
18. do. do. above, × 40.
19. do. do. below, × 40.
20. do. do. front, × 40.

Bairdia fulva.

21. Left valve, × 40.

Cythere pellucida.

22. Carapace, seen from left side, × 40.
23. do. do. above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.

Fig. 26. Separated valves, showing hinge-joint, × 40.
28. Old valve, from deep water, × 40.

Cythere castanea.

27. Carapace of female, from left side, × 40.

Cythere tenera.

29. Carapace (female), from left side, × 40.
30. do. do. above, × 40.
31. do. do. below, × 40.
32. do. do. front, × 40.

Cythere albo-maculata.

33. Carapace, seen from left side, × 40.
34. do. do. above, × 40.
35. do. do. below, × 40.
36. do. do. front, × 40.
37. Lucid spots, × 96.
38. Portion of anterior contact-margins, from the front, × 84.
38*a*. Young carapace, from left side (*C. alba*, Baird), × 40.
39. Separated valves, showing hinge-margins, × 40.

Cythere viridis.

40. Carapace of female, seen from left side, × 40.

Fig. 41. Carapace of female, seen from above, × 40.
57–59. Lateral, superior, and end views of specimens dredged in the Minch, × 40.

Cytheridea zetlandica.

42. Carapace, seen from left side, × 40.
43. do. do. above, × 40.
44. do. do. below, × 40.
45. do. do. front, × 40.
46. Lucid spots, × 84.

Cythere lutea.

(Deep-water variety.)

47. Right valve of male, × 40.
48. Carapace (female), seen from left side, × 40.
49. do. do. above, × 40.
50. do. do. front, × 40.
51. Separated valves, showing hinge-joint, × 40.

(Littoral variety.)

52. Carapace, from left side, × 40.
53. do. do. above, × 40.
54. do. do. below, × 40.
55. do. do. front, × 40.
56. Hinge-margins, from above: (*a*) left, (*b*) right, × 84.

Plate XXIX.

Cytheridea Sorbyana.

Fig. 1. Right valve (recent), × 40.
2. Carapace (fossil), seen from left side, × 40.
3. do. do. above, × 40.
4. do. do. front, × 40.
5. Left valve (recent), from side, × 40.
6. do. do. above, × 40.

Cythere mirabilis.

7. Left valve, seen from side, × 40.
8. do. do. above, × 40.

Limnicythere monstrifica.

9. Carapace, seen from left side, × 40.
10. do. do. above, × 40.
11. do. do. below, × 40.
12. do. do. front, × 40.

Limnicythere inopinata.

Fig. 15. Carapace of female, seen from left side, × 40.
16. Carapace of female, seen from above, × 40.
17. do. do. below, × 40
18. do. do. front, × 40.

Cythere convexa.

19. Carapace of female, seen from left side, × 40.
20. Carapace of female, seen from above, × 40.
21. do. do. below, × 40.
22. do. do. front, × 40.
23. Separated valves, showing hinge-margins, × 40.
24. Hinge-joint of left valve (lateral view), × 40.

Fig. 25. Outline of carapace, from right side, × 40.
26. do. right valve only, × 40.
27. do. left valve only, × 40.

Cythere villosa.

28. Carapace (female), seen from left side, × 40.
29. do. do. above, × 40.
30. do. do. below, × 40.
31. do. do. front, × 40.
32. Separated valves, showing hinge-margins, × 40.

Cythere semipunctata.

33–35. Carapace, lateral, upper, lower, and end views, × 40.
36. Right valve (young), lateral view, × 40.
37. do. do. from above, × 40.

Cytheropteron multiforum.

38. Carapace (of male), seen from left side, × 40.
39. Carapace (of male), seen from above, × 40.
40. do. do. below, × 40.
41. do. do. front, × 40.
42. Left valve (young), × 40.

Cytherura clathrata.

Fig. 43. Carapace, seen from left side, × 40.
44. do. do. above, × 40.
45. do. do. below, × 40.
46. do. do. front, × 40.

Cytherura cellulosa.

47. Carapace (female), seen from left side, × 40.
48. do. do. above, × 40.
49. do. do. below, × 40.
50. do. do. front, × 40.
60. do. do. left side, × 84.

Cythere Jeffreysii.

51. Carapace, seen from right side, × 40.
52. do. do. above, × 40.
53. do. do. below, × 40.
54. do. do. front, × 40.
55. Ornament of shell-surface, × 140.

Cythere badia.

56. Carapace, seen from left side, × 40.
57. do. do. above, × 40.
58. do. do. below, × 40.
59. do. do. front, × 40.

PLATE XXX.

Cythere dunelmensis.

Fig. 1. Carapace (male) (Durham coast), seen from left side, × 40.
2. Carapace (male), seen from above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.
5–8. The same, male (Frith of Clyde), × 40.
9. Carapace (female), seen from left side, × 40.
10. do. do. above, × 40.
11. do. do. below, × 40.
12. do. do. front, × 40.

Cythere Jonesii.

13. Carapace of female, seen from right side, × 40.
14. Carapace of female, seen from above, × 40.
15. do. do. below, × 40.
16. do. do. front, × 40.

Cythere antiquata.

Fig. 17. Carapace of female, seen from left side, × 40.
18. Carapace of female, seen from above, × 40.
19. do. do. below, × 40.
20. do. do. front, × 40.

Cythere Whiteii.

21. Carapace, seen from left side, × 40.
22. do. do. above, × 40.
23. do. do. below, × 40.
24. do. do. front, × 40.

Cythere tuberculata.

25. Carapace (female), seen from left side, × 40.
26. do. do. above, × 40.
27. do. do. below, × 40.
28. do. do. front, × 40.

Fig. 29. Separated valves, showing hinge-margins (Dogger bank), × 40.
30. Carapace (male), seen from left side, × 40.
31. do. do. above (Northumberland coast), × 40.
32. Carapace (female), seen from left side, × 40.
33. do. do. above (Durham coast), × 40.
34. Carapace (female), seen from left side, × 40.
35. do. do. above (Aberdeenshire), × 40.
36–39. Carapace, in different stages of growth, seen from left side (Northumberland and Durham coasts), × 40.
40, 41. Young carapace, lateral and ventral aspect, × 40.

Plate XXXI.

Cythere laticarina.

Fig. 1. Carapace, seen from left side, × 40.
2. do. do. above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.

Cythere marginata.

5. Carapace, seen from left side, × 40.
6. do. do. above, × 40.
7. do. do. below, × 40.
8. do. do. front, × 40.

Cythere finmarchica.

9. Carapace of female, seen from left side, × 40.
10. Carapace of female, seen from above, × 40.
11. do. do. below, × 40.
12. do. do. front, × 40.
13. Lucid spots, × 84.

Cythere oblonga.

14. Carapace (male), seen from left side, × 40.
15. Carapace of female, seen from left side, × 40.
16. Carapace of female, seen from above, × 40.
17. do. do. below, × 40.

Cythere quadridentata.

19. Carapace (male), seen from left side, × 40.
20. do. do. above, × 40.
21. do. do. below, × 40.
22. do. do. front (Durham coast), × 40.
23. Carapace (male) seen from left side, × 40.
24. do. do. above, (variety, Durham coast), × 40.
25. Right valve (Oban), × 40.
26. Left valve (female), old (Shetland), × 40.
27. Carapace (female), seen from left side, × 40.
28. Carapace (female), from above, × 40.
29. do. do. below, × 40.
30. do. do. front (Northumberland coast).

Cythere emaciata.

31. Carapace, seen from left side, × 40.
32. do. do. above, × 40.
33. do. do. below, × 40.
34. do. do. front (Plymouth), × 40.
35. Left valve, old (Galway), × 40.
36. Carapace, seen from left side, × 40.
37. do. do. below (Devonshire coast), × 40.

Cythere limicola.

38. Carapace of female, seen from left side, × 40.
39. Carapace of female, seen from above, × 40.
40. do. do. below, × 40.
41. do. do. front, × 40.
43. Left valve (young), seen from side, × 85.
44. do. do. above, × 85.
45. do. do. below, × 85.
46. do. do. front, × 85.

Cythere globulifera.

42. Right valve, × 84.

Cythere cuneiformis.

47. Left valve, lateral view, × 40.
48. do. seen from above, × 40.
49. do. do. below, × 40.

Cythere (?) *acerosa.*

Fig. 50. Left valve, front (adult female).
51–54. Perfect carapace (adult male), lateral, dorsal, ventral, and end views, × 40.

Fig. 55. Carapace, seen from left side, × 40.
56. do. do. above, × 40.
57. do. do. below, × 40.
58. do. do. front, × 40.

Plate XXXII.

Cytherura acuticostata.

Fig. 1. Carapace (male), seen from left side, × 40.
2. do. do. above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 40.
5. Carapace (female) from left side, × 40.
6. do. do. above, × 40.
7. do. do. below, × 40.
8. do. do. front, × 40.
9. Carapace (female, smooth variety), from left side, × 40.
10. Carapace (female, smooth variety), from above, × 40.
11. Carapace (female, smooth variety), from below, × 40.

Cytherura cornuta.

12. Carapace (female?), from left side, × 40.
13. do. do. above, × 40.
14. do. do. below, × 40.
15. do. do. front, × 40.

Cytherura Robertsoni.

16. Carapace (female), from left side, × 40.
17. do. do. below, × 40.
18. do. do. front, × 40.

Cytherura affinis.

19. Carapace (female), from left side, × 40.
20. do. do. below, × 40.
21. do. do. front, × 40.

Cytherura angulata.

22. Carapace, seen from left side, × 40.
23. do. do. above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.

Cytherura striata.

26. Carapace (female), from left side, × 40.
27. do. do. above, × 40.
28. do. do. below, × 40.

Fig. 29. Carapace (female), from front, × 40.
62. Sculpture of shell, × 210.
64. Carapace (female), from left side, × 84.
65. Interior of left valve, × 84.

Cytherura lineata.

30. Carapace of female, from left side, × 40.
31. do. do. below, × 40.
32. Carapace of male, from left side, × 40.
33. do. do. above, × 40.
34. do. do. front, × 40.
67. do. do. left side, × 84.

Cytherura cuneata.

35. Carapace (female), seen from left side, × 40.
36. Carapace (female), seen from above, × 40.
37. do. do. below, × 40.
38. do. do. front, × 40.
63. Sculpture of shell, × 210.

Cytherura Sarsii.

39. Carapace, seen from left side, × 40.
40. do. do. above, × 40.
41. do. do. below, × 40.
42. do. do. front, × 40.

Cytherura undata.

43. Carapace (male), from left side, × 40.
44. do. do. above, × 40.
45. do. do. below, × 40.
46. do. do. front, × 40.
47. Carapace (female), left side, × 40.
48. do. do. above, × 40.
49. do. do. below, × 40.
66. do. do. left side, × 84.

Cytherura nigrescens.

50. Carapace (female), from left side, × 40.
51. do. do. above, × 40.
52. do. do. below, × 40.
53. do. do. front, × 40.

Fig. 54. Carapace (variety, deep-water), from left side, × 40.
55. Ditto (ditto), from above, × 40.

Cytherura similis.

56. Carapace (female), from left side, × 40.
57. do. do. above, × 40.
58. do. do. below, × 40.
59. do. do. front, × 40.

Cytherura producta.

60. Carapace of male, seen from left side, × 40.
61. Carapace of male, seen from below, × 40.

Cytherura gibba.

Fig. 68. Carapace (female), from left side, × 40.
69. do. do. above, × 40.
70. do. do. front, × 40.

Cythere rubida.

71. Carapace (female), from left side, × 40.
72. do. do. above, × 40.
73. do. do. below, × 40.
74. do. do. front, × 40.

Cythere dubia.

75. Carapace, seen from left side, × 40.
76. do. do. above, × 40.

Plate XXXIII.

Bradycinetus globosus.

Fig. 1. Carapace seen from left side, × 20.
2. do. do. above, × 20.
3. do. do. below, × 20.
4. do. do. front, × 20.
5. Hinge-margins, × 16.

Cylindroleberis teres.

6. Carapace, seen from left side, × 20.
7. do. do. above, × 20.
8. do. do. below, × 20.
9. do. do. front, × 20.

Philomedes interpuncta.

10. Carapace, seen from left side, × 20.
11. do. do. above, × 20.
12. do. do. below, × 20.
13. do. do. front, × 20.

Bradycinetus Macandrei.

Fig. 14. Carapace, seen from left side, × 20.
15. do. do. above, × 20.
16. do. do. below, × 20.
17. do. do. front, × 20.

Cylindroleberis Mariæ.

18. Carapace, seen from left side, × 20.
19. do. do. above, × 20.
20. do. do. below, × 20.
21. do. do. front, × 20.
22. Lucid spots, × 84.

Bythocythere simplex.

23. Carapace, seen from right side, × 40.
24. do. do. above, × 40.
25. do. do. below, × 40.
26. do. do. front, × 40.
27. Lucid spots, × 84.

Plate XXXIV.

Bairdia complanata.

Fig. 1. Carapace, seen from left side, × 40.
2. do. do. above, × 40.
3. do. do. below, × 40.
4. do. do. front, × 50.

Sclerochilus contortus.

5. Carapace of female, seen from left side, × 40.
6. Carapace of female, seen from above, × 40.
7. do. do. below, × 40.
8. do. do. front, × 40.

Fig. 9. Separated valves, showing hinge-margins, × 40.
10. Lucid spots, × 84.

Ilyobates bartonensis.

11. Carapace of female, seen from left side. × 40.
12. do. do. above, × 40.
13. do. do. below, × 40.
14. do. do. front, × 40.

Cytherella lævis.

Fig. 15. Right valve, seen from side, × 40.
16. do. do. above, × 40.
17. do. do. front, × 40.

Cytherella scotica.

18. Carapace, seen from left side, × 40.
19. do. do. above, × 40.
20. do. do. below, × 40.
21. do. do. front, × 40.

Bairdia obtusata.

22. Carapace, seen from left side, × 40.
23. do. do. above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.

Cytheropteron latissimum.

26. Carapace, seen from left side, × 40.
27. do. do. above, × 40.
28. do. do. below, × 40.
29. do. do. front, × 40.
30. Separated valves, showing hinge-joint, × 40.

Cytheropteron nodosum.

31. Carapace, seen from left side, × 40.
32. do. do. above, × 40.
33. do. do. below, × 40.
34. do. do. front, × 40.

Bythocythere turgida.

Fig. 35. Carapace (female), seen from left side, × 40.
36. Carapace (female), seen from above, × 40.
37. do. do. below, obliquely, × 40.
38. Lucid spots, × 84.

Cytheropteron subcircinatum.

39. Carapace, seen from the left side, × 56.
40. do. do. above, × 56.
41. do. do. below, × 56.
42. do. do. front, × 56.

Pontocypris (?) *angusta.*

43. Carapace, seen from left side, × 56.
44. do. do. above, × 56.

Cytheropteron punctatum.

45. Carapace, seen from left side, × 40.
46. do. do. above, × 40.
47. do. do. below, × 40.
48. do. do. front, × 40.

Pseudocythere caudata.

49. Carapace, from left side, × 40.
50. do. above, × 40.
51. do. below, × 40.
52. do. front, × 40.

Cytheridea (?) *subflavescens.*

53. Carapace, seen from left side, × 40.
54. do. do. below, × 40.
55. do. do. front, × 40.

Plate XXXV.

Paradoxostoma variabile.

Fig. 1. Carapace of female (from deep water, 1–60 fathoms), seen from left side, × 40.
2. Carapace of female, seen from above, × 40.
3. do. do. front, × 40.
4. Carapace of female, seen from left side, × 40.
5. Carapace of female, littoral variety, seen from above, × 40.
6. do. do. below, × 40.
7. do. do. front, × 40.
12. Carapace of female (from roots of *Laminaria* beyond low-water mark), seen from left side, × 40.
13. Carapace of female, seen from above, × 40.
14. Young carapace (littoral variety), seen from left side, × 40.
15. do. do. above, × 40.
16. do. do. front, × 40.
17. Aperture between contact-margins for protrusion of suctorial apparatus, × 140.

Paradoxostoma ensiforme.

8. Carapace, seen from left side, × 40.
9. do. do. above, × 40.

Fig. 10. Carapace, as seen from below, × 40.
11. do. do. front, × 40.

Paradoxostoma obliquum.

18. Carapace, seen from left side, × 40.
19. do. do. above, × 40.
20. do. do. below, × 40.
21. do. do. front, × 40.

Paradoxostoma abbreviatum.

22. Carapace (female), seen from left side, × 40.
23. Carapace (female), seen from above, × 40.
24. do. do. below, × 40.
25. do. do. front, × 40.

Paradoxostoma sarniense.

26. Carapace (female), seen from left side, × 40.
27. Carapace (female), seen from above, × 40.
28. do. do. below, × 40.
29. do. do. front, × 40.

Paradoxostoma flexuosum.

30. Carapace, seen from left side, × 40.
31. do. do. above, × 40.
32. do. do. below, × 40.
33. do. do. front, × 40.
34. Left valve from above, showing hinge-margin, × 40.

Paradoxostoma hibernicum.

35. Carapace (female), seen from left side, × 40.
36. Carapace (female), seen from above, × 40.

Paradoxostoma arcuatum.

Fig. 37. Carapace, seen from left side, × 40.
38. do. do. above, × 40.

Paradoxostoma Normani.

39. Carapace, seen from left side, × 40.
40. do. do. above, × 40.

Paradoxostoma pulchellum.

41. Carapace, seen from left side, × 40.
42. do. do. above, × 40.

Cytherideis subulata.

43. Carapace, seen from left side, × 40.
44. do. do. above, × 40.
45. do. do. below, × 40.
46. do. do. front, × 40.

Bythocythere constricta.

47. Carapace of female, from left side, × 40.
48. Carapace of male, from left side, × 40.
49. do. do. above, × 40.
50. do. do. below, × 40.
51. do. do. front, × 40.
52. Outlines of separate valves, showing hinge-margins, × 40.

Polycope orbicularis.

53. Carapace, seen from right side, × 120.
54. do. do. above, × 120.
55. do. do. behind, × 120.
56. Imperfect valve (Roundstone), × 84.
57. Sculpture of shell, × 140.

Polycope dentata.

58. Carapace, seen from left side, × 84.
59. do. do. below, × 84.

PLATE XXXVI.

In this and the following Plates (except Plate XLI.), illustrating details of anatomical structure, the letters (*a*, *b*, *c*, &c.) uniformly refer to one and the same organ, except when otherwise stated in the explanatory text. The letters refer as follows:—

a. Upper antenna.
b. Lower antenna: *a'*, poison-gland; *b'*, flagellum or urticating seta.
c. Mandible: *a'*, palp; *b'*, branchial appendage.
d. First maxilla: *a'*, external palp; *b'*, branchial plate.
e. Second maxilla: *a'*, palp; *b'*, branchial appendage.
f. First foot.
g. Second foot.
h. Third foot.
i. Postabdominal ramus.
k. Male copulative organ.
l. Male "glandula mucosa."

Fig. 1. *Cypris virens*, female, × 85 (fig. *a* × 40).
m. Mouth, × 320.
n. Receptaculum seminis and duct, × 210.
Fig. 2. *Cypris gibba*, female, × 145.
Fig. 3. *Cypris serrata*, female, × 120.
Fig. 4. *Cypris reptans*, female, × 85.
Fig. 5. *Cypris lævis*, female, × 210.
Fig. 6. *Cypris compressa*, male.
a. Copulative organs, × 210.
m. Extremity of "mucus-gland," × 210.
n. do. mandibular palp, × 210.
Fig. 7. *Cypris cinerea*, female, × 210.
Fig. 8. *Cypris ovum*, male, × 210.
Fig. 9. *Cypridopsis villosa*, × 400.
Fig. 10. *Cypridopsis aculeata*, × 400.
Fig. 11. *Cypris punctillata*.
Extremity of mandible, × 210.
Fig. 12. *Candona albicans*, female.
m. Biarticulate seta of lower antenna, × 600.
i. Postabdominal ramus, × 210.
n. Palp of second jaw, × 210.
Fig. 13. *Candona candida*, male.
k. Copulative organs, × 85.

Plate XXXVII.

Fig. 1. *Candona candida*, × 85.
m. Portion of the mucus-gland highly magnified, × 210.
t. Portion of a spermatozoid, × 600.
Fig. 2. *Candona detecta*, female, × 210.
m. Terminal claws of postabdomen, × 400.
Fig. 3. *Notodromas monachus*.
e'. Second jaw and palp, female, × 210.
e''. do. right side, male, × 85.
e'''. do. left side, male, × 85.
f'. Foot of first pair, female, × 210.
f''. do. male, × 210.
g. Extremity of second foot, male, × 210.
c. Mandible with palp and branchial appendage, × 210.
b. Terminal joints of lower antenna, × 96.
l. Glandula mucosa, × 96.
k. Copulative organs, male, × 120.
Fig. 4. *Pontocypris mytiloides*, × 210.
g. Extremity of second foot, × 210.
e'. Left jaw of second pair, male, × 210.
e''. Palp of second jaw, female, × 210.
c. Mandible: *a'*, palp of mandible, × 210.
j. Suprabasal seta of do., × 210.
o. Intestinal canal with dilatations, × 210.
k. Copulative organs, male, × 85.
m. Posterior spines of right valve, × 210.

Plate XXXVIII.

Fig. 1. *Pontocypris mytiloides*.
Branchial plate of first jaw, × 210.
Fig. 2. *Paracypris polita*, × 210.
Fig. 3. *Pontocypris trigonella*, × 210.
Fig. 4. *Macrocypris minna*, × 85.
m. Coil of spermatic filaments, × 400.
Fig. 5. *Bairdia inflata*, × 210.
Fig. 6. *Cythere castanea*, × 210.
Fig. 7. *Cythere concinna*, × 210.
m. Terminal claw of last foot.
n. Terminal claw of first foot.
Fig. 8. *Cythere viridis*, × 210.
Fig. 9. *Limnicythere inopinata*, × 210.
i. Abdominal lobes and setæ, × 400.
m. Appendage of do., × 400.

Plate XXXIX.

Fig. 1. *Lymnicythere inopinata*, × 210.
Fig. 2. *Cythere lutea*, × 210.
k. Copulative organs, male.
p. Penis.
i. Postabdomen.
Fig. 3. *Cythere albomaculata*, × 210.
b. Terminal joints of lower antennæ, male and female.
m. Homologue of second maxilla, × 400.
Fig. 4. *Cythere convexa*, × 210.

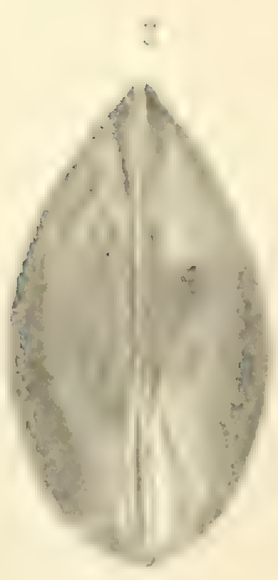
Fig. 5. *Cytheridea torosa*, × 210.
m. Abdomen of female, × 84.
n''. Second joint of last right foot of the male, × 210.
o. Ringed seta of last foot, × 400.
h. Foot of last pair (left) of male, × 210.
g. do. second pair (right) of male, × 210.
g''. Foot of second pair (left) of male, × 210.
f. do. first pair (female), × 210.
f''. do. do. (male, right), × 210.
k. Copulative organs of male, × 84.
p. Branchial appendage of mandible palp, × 210.
Fig. 6. *Xestoleberis aurantia*, × 210.
Fig. 7. *Cytherura nigrescens*, × 210.

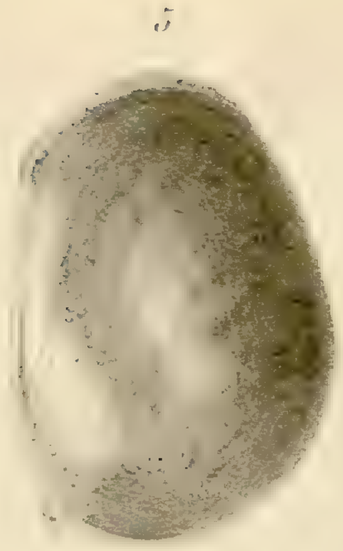
Plate XL.

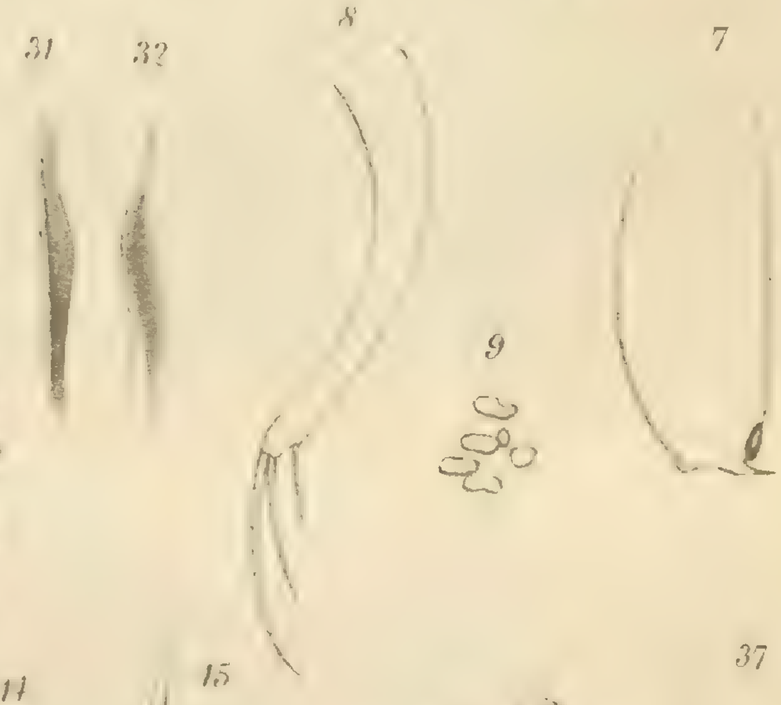
Fig. 1. *Cytheridea papillosa*, × 210.
h. Third foot, male.
f. First foot (right) of male.
f''. do. female, and left of male.
Fig. 2. *Cytheridea lacustris*, female, × 210.
Fig. 3. *Loxoconcha elliptica*, × 210.
Fig. 4. *Loxoconcha impressa*, × 210.
k. Apical portion of copulative organs of male.
m. Abdominal lobe.
Fig. 5. *Ilyobates bartonensis*, × 210.
Fig. 6. *Cytheridea elongata*, male, × 210.
Fig. 7. *Paradoxostoma hibernicum*, × 210.
o. Extremity of mandible.
Fig. 8. *Bythocythere simplex*, × 84.
Fig. 9. *Paradoxostoma sarniense*, × 210.

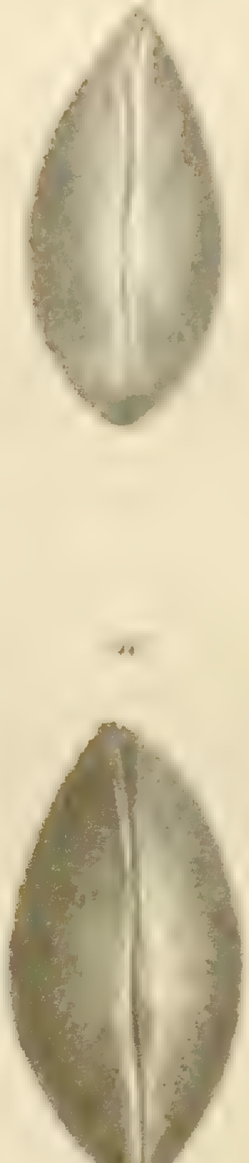
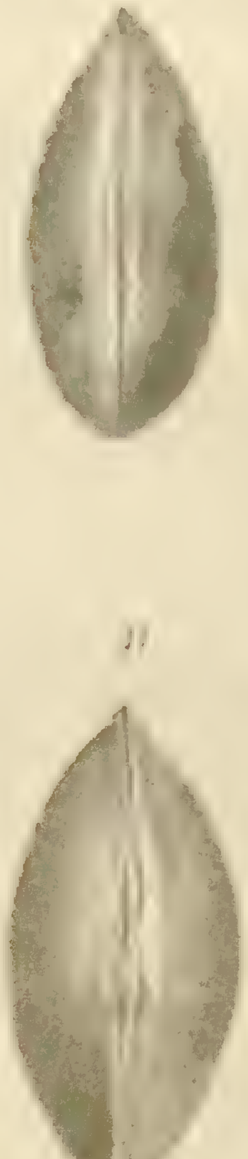
Plate XLI.

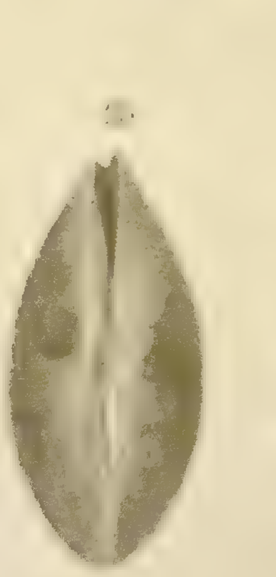
Fig. 1. *Cylindroleberis Mariæ*.
a. Upper antenna of male, × 40.
b. do. female, × 84.
c. Lower antenna of female, × 40; *c''*, secondary branch, × 40.
d. Secondary branch of lower antenna of male, × 84.
e. Mandibular foot, × 84; *e''*, first maxilla.
f. Second maxilla, × 84.
g. Third maxilla, × 84.
n. Abdominal laminæ, × 84.
i. Extremity of "oviferous foot," × 210.
Fig. 2. *Cylindroleberis teres*, female, × 84.
a. Upper antenna, × 84.
b. Mandibular foot, × 84.
c. First maxilla, × 84.
d. Abdominal lamina, × 84.
Fig. 3. *Philomedes interpuncta*.
a. Secondary branch of lower antenna, × 84.
b. Mandibular foot, × 84.
c. Third maxilla, × 84.
d. Extremity of oviferous foot, × 210.
e. Abdomen, seen from side, × 84.
f. Abdomen, seen from below, × 84.
Fig. 4. *Bradycinetus Macandrei*.
Secondary branch of lower antenna, female, × 210.
Fig. 5. *Bradycinetus brenda*.
a. Upper antenna of female, × 84.
b. Mandibular foot of female, × 84.
c. First maxilla of female, × 84.
d. Second maxilla with portion of branchial plate, × 84; *d''*, mandibuliform processes.
Fig. 6. *Pseudocythere caudata*.
Third foot, × 210.
Fig. 7. *Sclerochilus contortus*.
a. Upper antenna, × 210.
d. First maxilla, × 210.
f. First foot, × 210.
k. Copulative organs, male, × 210.
Fig. 8. *Paradoxostoma variabile*.
a. Upper antenna, × 210.
b. Lower antenna, × 210.
g. Second foot, × 210.
h. Third foot, × 210.
Fig. 9. *Conchœcia obtusata?*, × 40.

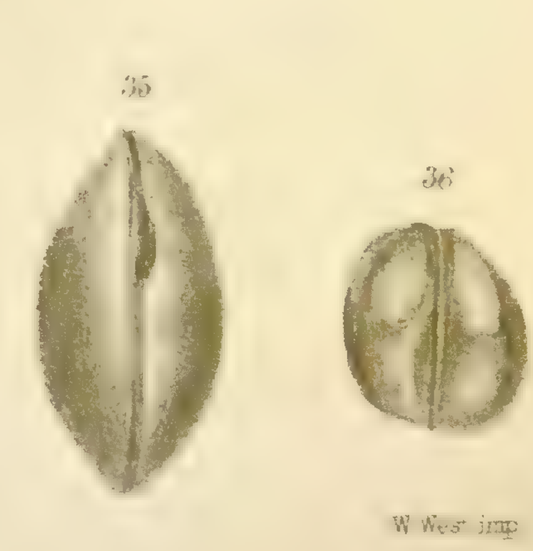






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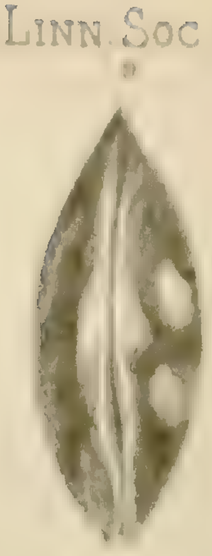

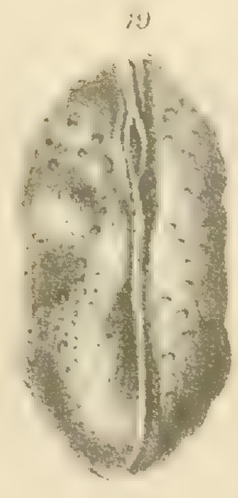

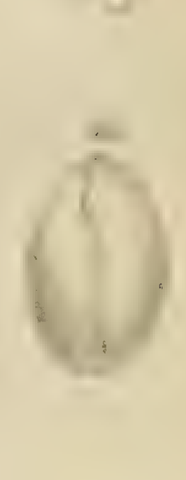
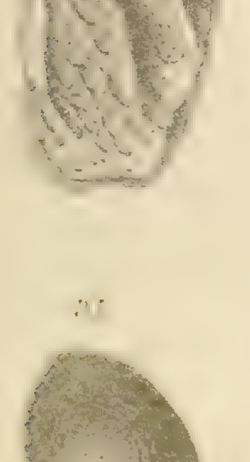

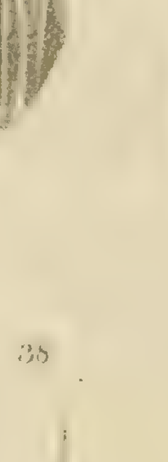

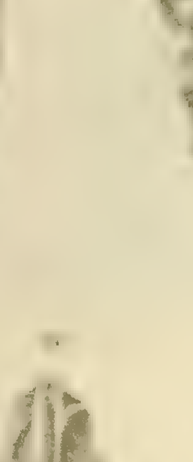

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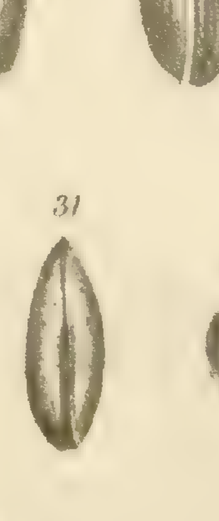

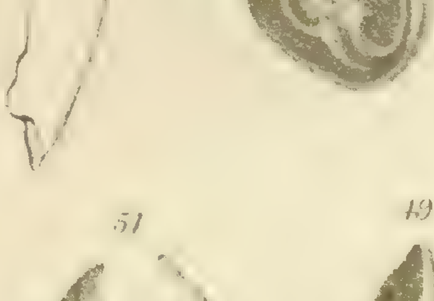

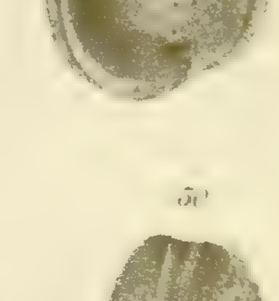
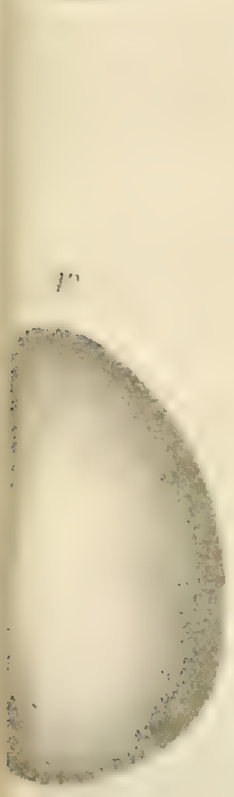
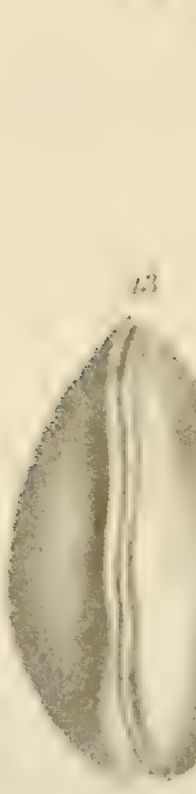
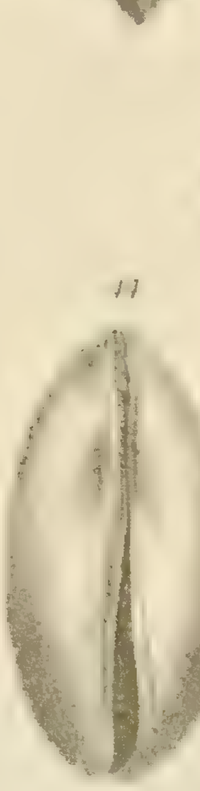

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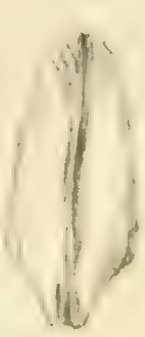
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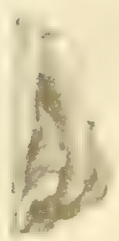
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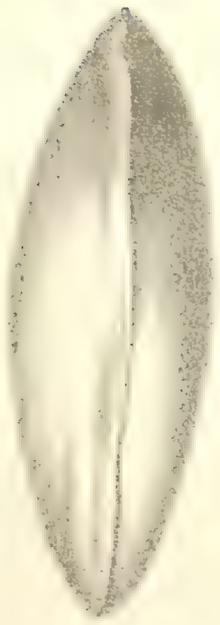
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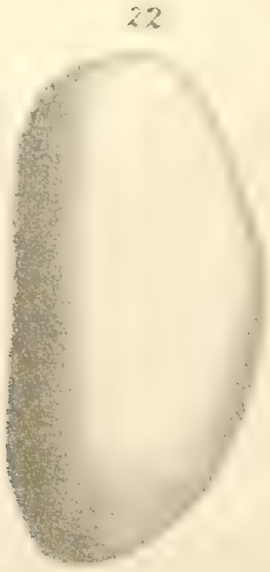
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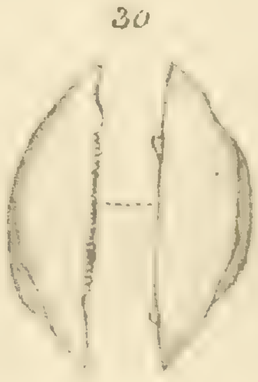
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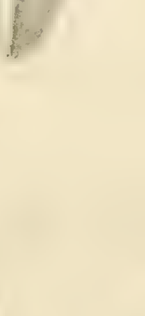
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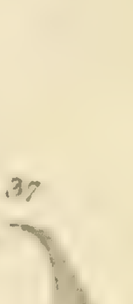
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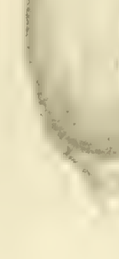
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THE

TRANSACTIONS

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THE LINNEAN SOCIETY

OF

LONDON.

VOLUME XXVI.

PART THE THIRD.

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M.DCCC.LXIX.

X. *On some remarkable Mimetic Analogies among African Butterflies.*

By Roland Trimen, *Mem. Ent. Soc. Lond.*

(Plates XLII. & XLIII.)

Read March 5th, 1868.

* * * * * "C'est une chose bien remarquable que de voir la nature créer à côté les uns des autres *l'Euplœa Niavius*, le *Diadema dubia*, et le *Papilio Westermanni*, trois Lépidoptères qui se ressemblent presque complétement par le port, le dessin, et la couleur, quoique appartenant à des genres fort éloignés et de tribus différentes."—Boisduval, *Species Général des Lépidoptères*, pp. 372, 373.

From the year 1836, when Dr. Boisduval published these remarks, a period of twenty-five years elapsed without any light being thrown upon the meaning of those remarkable resemblances among the *Rhopalocera* which are familiar to every lepidopterist, which have been noted by entomologists in publications both prior and subsequent to the date of the 'Species Général,' and to one of the most striking of which the above quotation refers. The extraordinary fact, that in all parts of the world species of Butterflies occurred which, aberrant from the normal *facies* of their immediate allies, most closely resembled other species of wholly different structure, awakened no comment beyond the admission that it was curious, unless it were some vague suggestion as to "recurrent types" in nature, which left the subject as completely mysterious as before. Entomologists, no less than naturalists generally, appeared content with a child-like wonder at this and kindred facts, and let them pass as things inscrutable. That this neglect of inquiry was due in great measure to the absence of reliable observations upon the living insects in their native haunts, cannot be doubted; but it may be questioned if, with all the data now accumulated by various explorers, those whose energies were necessarily, and in many cases exclusively, concentrated upon the arduous work of the systematist would have been enabled to elucidate the subject. It remained for one of those adventurous lovers of nature whose zeal for discovery leads them to years of tropical wanderings, to indicate, from his own assiduous observations, and in the light of that comprehensive theory of organic nature which we owe to Mr. Darwin, the rational explanation of these phenomena. That this explanation is absolutely conclusive, or not susceptible of future modification, it would be premature to assert; but it is indisputably the only advance yet made towards the solution of the difficulty, and so reasonable a demonstration as to commend itself to every thoughtful observer. I need scarcely say that I refer to the well-known treatise by Mr. Bates on the *Heliconidæ* of the Amazons Valley (published in the twenty-third volume of the 'Transactions of the Linnean Society'), in which the principle of natural selection is most ably applied in elucidation of the origin and development of those "mimicries" of which many are now so astonishingly exact. The

view propounded by Mr. Bates has met with the weighty support of Mr. Wallace, who, in his interesting paper on Malayan *Papilionidæ**, has called attention to an analogous series of phenomena presented in India and the great Eastern Archipelago, and can only account for them on the same theory.

My object in the present paper is to give some account of the most striking cases of mimetic analogy which have been found to exist among the Butterflies of Africa, more especially regarding those occurring at the southern extremity of the continent, a region in which I have had the advantage of several years' personal research.

In the first place, it is eminently worthy of remark that the Butterflies which are the subjects of imitation by others, belong to the same families both in the Old World and the New. The *Danaidæ* and *Acræidæ*, throughout the warmer parts of the earth, are unquestionably the special groups that furnish the models after which more or less perfect copies have been elaborated. This being an acknowledged fact, we are naturally led to inquire why it should be so—what advantage is to be gained by closely resembling the members of those families. Is there anything connected with those groups tending to show that they possess advantages above others of their Order? Do they appear, from their numbers and habits of life, to be dominant races?

These inquiries can unhesitatingly be answered in the affirmative. The slow flight, the conspicuous colours, the complete disregard of concealment, no less than the great abundance of individuals, are characteristics indicating unmistakably that these Butterflies are favoured races, enjoying advantages and immunities above their fellows. I believe that Mr. Bates (*loc. cit.* p. 510) has correctly suggested the principal causes of the evident security of these insects, viz. their emitting an unpleasant odour, and being probably distasteful to insectivorous animals. The peculiar smell noticed by Mr. Bates in the Heliconide *Danaidæ* is also possessed by the *Euplœæ* of the Eastern Archipelago, as Mr. Wallace has recorded; and I am enabled to add similar evidence as regards the African species of *Danais* and *Acræa*†. Judging from the case of *Acræa Horta*, a widely-distributed African species, which I have reared in considerable numbers from the young larvæ, this disagreeable smell is not peculiar to the imago condition, but attends the insect throughout its life, even the pupæ emitting it. On pressing the thorax of a *Danais*, a *Euplœa*, or an *Acræa*, however lightly, a clear yellow liquid, similar to that secreted by the Ladybird beetles, almost always exudes from that part of the body; and in some species of the two former genera a pair of bright-yellow fascicled appendages are protruded from the extremity of the abdomen‡. The peculiar scent appears chiefly to reside in this liquid, being remarkedly stronger with each effusion. Most of the species of *Danais* and *Acræa* feign death very readily; and they possess another means of defence which, as far as I am aware, has not hitherto been recorded, viz. the remarkable elasticity of their entire structure. No pressure of the thorax, short of absolute crushing of the tissues, suffices to kill or even paralyze these Butterflies; and the collector who treats

* Trans. Linn. Soc. vol. xxv.

† The Mauritian *Euplœa Euphone* also gives out a strong odour when handled.

‡ Mr. Bates mentions that species of the genera *Lycorea* and *Ituna* (Heliconide *Danaidæ*) possess similar exsertile organs.

them as he would species of other families, soon finds his collecting-box alive with its struggling occupants. So flexible are the wings, that the insect generally succeeds in withdrawing them from crossed fences of pins which form a complete barrier to any motion on the part of ordinary Butterflies; and however bent and distorted the wings may become in such exertions, I have never known a fracture of nervures or membrane to result, the organs resuming their natural position even after having been bent double for some hours. While entomologizing in Natal, my Kafir collector used often to bring me numerous examples of the commonest species in his box, and when engaged in the necessary work of rejection, I constantly found the limp-winged *Danaidæ* and *Acræidæ*, as soon as they were released from the transfixing-pin, fly off with perfect ease and apparent *nonchalance*.

It is not difficult to perceive how important, as a reserve means of defence, this unusual elasticity of structure may prove. That birds, and other eaters of insects, may occasionally capture a Butterfly of these malodorous tribes before discovering its distasteful character is not an unreasonable supposition, especially in seasons when an exceptional scarcity of some favourite food may prevail. In such a case it may be safely stated that the chances are very greatly in favour of a *Danais* or an *Acræa* escaping, if not wholly unhurt, yet without serious injury, after rough treatment that would have proved fatal to a harder but less elastic animal*.

More extended observation is necessary to prove by positive evidence that persecution of the *Danaidæ* and *Acræidæ* has almost wholly ceased, although, negatively, the witness borne by their abundance is very strongly in favour of this view. Some check upon their inordinate increase must, of course, exist; and this is probably to be found in the Ichneumon flies attached to the various species, the females of which are not likely to be deterred by any odour from depositing their ova in the larvæ. Mr. Bates has recorded that the Heliconide *Danaidæ*†, when at rest on leaves, did not "appear to be molested by lizards or predaceous flies of the family *Asilidæ*, which were very often seen pouncing on Butterflies of other families." A well-known naturalist has quoted (in the Westminster and Foreign Quarterly Review for July 1867, Article 1) an observation by Mr. Belt, that a pair of Puff-birds, watched by him in Brazil, during half-an-hour caught and brought to their nest various butterflies to feed their young, but entirely avoided the slow-flying *Heliconidæ*, which were about the spot in great numbers‡. I

* This elasticity of structure is not confined to the Butterflies in question, being a character of many Moths, and markedly of some belonging to the families *Agaristidæ* and *Zygænidæ*. It is remarkable that the three South-African Moths in which I have found this peculiarity most developed, viz. *Pais decora*, *Eusemia euphemia*, and *Glaucopis formosa*—all have a strong and offensive odour, emit drops of white or yellow fluid, and are slow-flying, brightly coloured, and abundant species.

† The term used by Mr. Bates is "Danaoid *Heliconidæ*": but as it is clear that that author agrees with Dr. Felder in recognizing all the so-called *Heliconidæ* except *Heliconius* and *Eueides* as forming a part of the family *Danaidæ*, I have ventured to transpose the words in order the more distinctly to express this relationship.

‡ It is not uncommon to hear doubt expressed as to whether birds even feed on butterflies at all; and thus the case just mentioned is of importance. I have noticed a Swallow chasing a *Pieris Brassicæ* in England; and I never knew it to be disputed that the Goatsuckers eat the nocturnal Lepidoptera. But when one reflects on the host of insectivorous birds in all (and especially in tropical) countries, it would be marvellous indeed if they neglected the large supply of food afforded by the generally defenceless race of Butterflies.

have published ('Rhopalocera Africæ Australis,' pt. ii. p. 335) an interesting note by Mr. J. H. Bowker on the manner in which *Junonia Œnone*, one of the *Nymphalidæ*, is systematically hunted down by a small Kaffrarian lizard. This *Junonia* is a particularly wary, active insect, and must give its pursuers infinitely more trouble to capture than would the slow, inert, grass-loving *Acrææ* of the same district; yet the lizards leave the latter unmolested. On more than one occasion, I have seen the larger Dragonflies catch Butterflies, both in England and Natal. *Pieridæ* were the victims in both countries; but in Natal the ubiquitous *Acrææ* were certainly passed by, and the more active insects selected. In the colony in question, several species of *Acacia* secrete a viscid fluid; and the spaces on the branches where this freshly exudes from the bark are a great resort of insects of all Orders, which assemble to imbibe the liquid. The larger *Mantidæ* take advantage of these gatherings to secure a plentiful and easy living; and one of them is usually to be seen among or close to the group of butterflies, beetles, wasps, ants, and flies attracted to the feast. As long as there is anything left to drink, there is no lack of visitors, and the *Mantis* fattens on numerous victims. The wings rejected by the devourer, who seems to prefer butterflies to other insects, in a short time rather conspicuously sprinkle the ground or herbage under one of these feeding-places; and in a few instances, where I chanced upon accessible spots, I searched among the *disjecta membra* for remains of *Danais* or *Acræa*, but in vain. It is necessary to observe that I cannot recollect having distinguished Butterflies of either of those genera at such drinking-stations; but the exudations were often situated at a height that precluded the certain distinction of any but very large insects, and there is apparently no reason why the fluid so universally appreciated should fail to attract those butterflies.

I think that the facts already placed on record, to the more important of which I have referred, may fairly be urged in support of the position that the *Danaidæ* and *Acræidæ* are exempted or protected in a very great degree from the attacks of those enemies to which the diurnal Lepidoptera generally, in their adult state, are constantly exposed. There are many instances of Butterflies, of various families, whose great abundance indicates that they have, by some means, attained immunity from persecution, or risen superior to adverse circumstances; but, as groups, the *Danaidæ* and *Acræidæ*, wherever they occur, are unquestionably preeminent in individuals, if not in species, and must take rank as the most perfectly adapted of all their Order to the existing conditions of life.

It is not surprising to find that those families of Butterflies which hold the first place in the battle of life display a structure which has led Mr. Bates to assign to them a position, in a "natural system" of classification, at the head of the order Lepidoptera*. The atrophy of the fore legs is a special character of the Rhopalocera as a group, which most widely distinguishes them from the Heterocera and from other Orders of insects; and this has been tacitly recognized by the universal consent with which entomologists have assigned the lowest place among Butterflies to the *Hesperiidæ*, a family which shows its affinity to the Moths by the fully developed fore legs, as well as by other cha-

* See Trans. Linn. Soc. vol. xxiii., and Journal of Entomology, December 1861, and No. X. 1864.

racters of importance. The splendid family *Papilionidæ*, by mere force of the size, number, and beauty of its members, has so long held the place of honour in English and in most continental classifications, that many lepidopterists are loth to supplant it by a comparatively insignificant-looking group; but, regarding the question structurally, there can be no doubt that an arrangement which interposed between the only families with fully developed fore legs (viz. the *Papilionidæ* and *Pieridæ* at one end of the series, and the *Hesperiidæ* at the other) all the groups that more or less widely differed in the character of those very organs was artificial and unnatural. On the other hand, Mr. Wallace (*loc. cit.* p. 2) has questioned the propriety of claiming a high position for any group on the ground of extreme imperfection of any of its organs. Taken apart from other considerations, this at first sight appears a valid objection; but it must be borne in mind, as suggested by Mr. Bates, that the Lepidopterous type among Articulata, like that of the Bird among Vertebrata, is preeminently aerial, and, consequently, that a diminution of the ambulatory organs, instead of being a sign of inferiority, may very possibly indicate a higher (because more thoroughly aerial) form. Mr. Wallace further contends for the first rank being accorded to the *Papilionidæ*, on account of the perfect insects possessing the peculiar and constant character of an apparently 4-branched median nervure, and a "spur"* on the anterior tibiæ, and the larvæ having an extrusible Y-shaped tentacle. The appendage to the anterior tibiæ is admitted by Mr. Wallace to be a character of some *Hesperiidæ*; and not having been found in other Butterflies, it may fairly be regarded, in conjunction with the full development of the first pair of legs, as a sign of affinity, however distant, between the two families. The apparent fourth branch of the median nervure is not an *additional* nervule, but actually the lower radial ("second discoidal nervule" of Doubleday) unusually placed in relation to the third branch of the nervure, and thus can hardly be regarded as in any way significant of superior development†. Nor can the Y-shaped tentacle of the larva be insisted

* This is more strictly a small foliated expansion or appendage.

† More remarkable points in the neuration of the *Papilionidæ* are the following, viz.:—1st, the short, transverse, *interno-median* nervule, uniting the median and submedian nervures of the fore wings, and closing a small basal cell; 2ndly, the well-marked *internal* nervure of the same wings, which has an independent course, and terminates on the inner margin; and, 3rdly, the distinct prediscoidal cell of the hind wings, formed by the junction of the branched precostal nervure with the costal. *Papilio* (including *Ornithoptera*) appears constantly to present these characters, with some variation in the size of the prediscoidal cell of the hind wings; the Australian *Eurycus* also possesses them all, and has the prediscoidal cell unusully large; in *Sericinus*, *Teinopalpus*, and *Leptocircus* appear the internal nervure (but *not* the interno-median nervule) of the fore wings and a much-narrowed prediscoidal cell: *Parnassius* and *Thais* present only the internal nervure of the fore wings; and in the aberrant *Doritis* I can trace none of the three characters. In other families we find the transverse *interno-median* nervule in several of the *Morphidæ*, though not so completely developed; the *internal* nervure is present in the *Danaidæ*, but, instead of having an independent course, is intimately connected with the submedian nervure, and ends by anastomosing with it; while the prediscoidal cell of the hind wings has hitherto been employed as the distinguishing feature of the curious *Brassolidæ*, in which it is formed in precisely the same manner as in the *Papilionidæ*.

The presence of additional cells, enclosed by anastomosing nervures, is a feature not rare among the Heterocera (*vide* the plates of neuration in Guenée's 'Noctuélites' and 'Phalénites'); and in some genera of Geometræ (*Oporabia*, *Ennomos*, &c.) a cell is found at the base of the hind wings, occupying exactly the same position as in the Butterflies mentioned.

on as indicating perfection of the Rhopalocerous type, when it is considered that the only known instances of an organ similar in structure and function in the rest of the Lepidoptera are found, not in Butterflies of any family, but in *Cerura*, a genus of Bombycide Moths. The organ of the Puss-Moth caterpillars is double, instead of forked, and occupies the opposite extremity of the body; but it is plainly homologous to that of the *Papilio* larvæ, and is protruded on occasion in precisely the same manner. Looking to the pupæ of the several families, we find, receding from those of the Heterocera in silken, earthen, or other cocoons, or buried in the ground, a gradual advance, corresponding with that towards a more aerial type of imago, to the freely suspended chrysalis of the tetrapod Rhopalocera. The pupæ of the *Hesperiidæ* are secured, like those of many moths, either in a slight cocoon or by several silken threads; those of the *Papilionidæ*, *Pieridæ*, and *Lycænidæ**, by the tail and by a single silken girdle; while, through the *Erycinidæ*, which present instances both of girt and freely suspended pupæ†, there is a gradation to the chrysalides of the true Nymphalide Butterflies, which hang, head downwards, by a caudal attachment only. The remarkable pupa of *Parnassius*, more heteroceroid (in its blunted form, bluish efflorescence, and numerous threads of support in a cocoon of leaves) than most of those known among the *Hesperiidæ*, seems to afford an additional indication of some connexion between the *Papilionidæ* and Moths. Another singular fact tends to strengthen the idea of a remote, but distinct relationship, viz. that the pupæ of *Ephyra*, a Geometrine genus, are not only suspended by the tail and a silken girth, in precisely the same position as those of the *Papilionidæ*, but closely resemble them in form, M. Guenée observing ('Phalénites,' ix. p. 402) that they can best be compared with the chrysalides of *Thais*‡. Similar, also, in their caudal attachment and silken girdle, but not so like the *Papilio* chrysalides in form, are the pupæ of the very curious Heterocerous group of *Pterophoridæ*, which stands alone in the structure of its wings, and has hitherto, by common consent, been placed last in the entire order Lepidoptera.

It thus appears that the *Papilionidæ* exhibit points of structure in common with some Heterocera in each stage of their growth; and these characters seem, in the aggregate, of sufficient importance to warrant our assigning to the family a position much nearer to the Moths than that which, until lately, has so generally been accorded to it.

Turning to the *Danaidæ* and *Acræidæ*, which have so much in common both in structure and habits, it is curious to find how the two families differ in their early states. The larvæ of the Old-World *Danaidæ* are smooth, but provided with several pairs of long fleshy filaments; and, from the case of *Mechanitis Polymnia* (mentioned by Mr. Bates, *loc. cit.* p. 496), the Heliconide *Danaidæ* also present a smooth larva, which, however, is furnished with tubercles instead of filaments. The *Acræidæ* (of Africa) are, in the larva-state, densely studded with stiff branched spines; and the true (or Acræoid) *Heli-*

* The larvæ of some *Lycænidæ* (e. g. *Thecla Quercus*, L.) are stated to bury themselves in the earth before assuming the pupal condition.

† See Mr. Bates's 'Catalogue of Erycinidæ,' in Journ. Linn. Soc., Zool. ix. p. 368.

‡ Plate 2 of M. Guenée's volume gives an interesting figure of the pupa of an *Ephyra* in its natural position. *Thais* is recorded as having the chrysalis enclosed in a slight web, which is not the case with *Ephyra*.

coniidæ of America are similar in this respect, both groups showing affinity to the *Nymphalidæ* as far as the caterpillars are concerned. The thick, blunt chrysalis of the Danaide Butterflies also differs widely from the elongate, slender, and subangulated pupa of *Acræa*.

The African continent is very poor in *Danaidæ*, only eight species, belonging to two genera*, being known to inhabit its vast area. Seven belong to the genus *Danais*; and these, with the exception of *D. Chrysippus*, form a section confined to Africa, Madagascar, and Mauritius, and distinguished by a peculiar coloration of conspicuous ochre-yellow or white bands and spots on a black ground. Three of the six species appear to be confined in their range to the western coast, between Sierra Leone and Angola; one, with an equal range in the west, extends to the Zambesi and Natal; while two seem to be limited to extra-tropical Southern Africa. It is most remarkable to find, in this very limited number of *Danaidæ*, that no less than four are accompanied throughout their range each by its closely-imitating *Diadema*, one of the four (*Danais echeria*) being further attended by three mimicking species of *Papilio*, and another by one *Papilio* that correctly copies it. *Danais Chrysippus*, as is well known, has a faithful imitator everywhere, except in Europe, in the ♀ *Diadema Bolina*, and, in the south of Africa, finds a second mimicker in a rare form of *Papilio*, apparently peculiar to that region.

The *Acræidæ* have their metropolis in Africa, about fifty species being known from all parts of the Continent. Six *Acrææ* are distinctly the objects of mimicry by certain *Nymphalidæ* and *Papilionidæ*†. Four of these are West African only; one extends, under a somewhat altered form, to South Africa; and the sixth appears peculiar to the latter region. The mimickers here, also, are constant attendants on the species imitated; and in three cases, where the sexes of the *Acrææ* are dissimilar, the sexes of the mimickers differ accordingly.

It is worthy of notice that the mimicking *Papiliones*, whether imitators of *Danaides* or *Acrææ*, are very frequently only the *females* of the species, to the exclusion of the males, which, in such cases, wear the normal aspect of their immediate congeners‡. Among the *Diademæ* and other *Nymphalidæ*, on the contrary, both sexes of the mimickers,

* *Euplœa Goudotii*, well known as a native of Bourbon, is included, on the authority of Sir Andrew Smith, who presented a specimen from "South Africa" to the British Museum.

† The magnificent *Papilio Antimachus*, Drury, of which but one specimen is known to science, is very Acræiform in habit, and is possibly an instance of special modification in imitation of some gigantic *Acræa* as yet unknown, or perhaps extinct. Drury's having "received" this *Papilio* from Sierra Leone is, unfortunately, no clue to its actual *habitat*, the principal sea-ports in many parts of the world usually getting the credit of all natural objects, from whatever distance inland, that are shipped from them to Europe. *Antimachus* has the aspect of a slow and heavy flier; and the observation by Smeathman, quoted by Professor Westwood (Arc. Entom. i. p. 146), did not originally apply to the great *Papilio*, but to *Charaxes Camulus*, Drury (= *C. Castor*, Fab.), as may be seen on reference to Drury's 3rd volume, pp. 15–23, and pl. xxx.). Donovan, in his 'Naturalist's Repository,' first misquoted the passage respecting the flight of the *Charaxes*.

‡ Among fifteen Indian and Malayan imitative *Papiliones* tabulated by Mr. Wallace (*loc. cit.* p. 20), seven are expressly mentioned as females. As regards the African species, *Papilio Ridleyanus* is an instance of both ♂ and ♀ wearing the aspect of an *Acræa*, and, in a less degree, the southern form of *Papilio Leonidas*, which is the least accurate of the four mimickers of *Danais Echeria*; but in this case the majority of the specimens that most resemble the *Danais* are females.

as a rule *, present, with equal exactness, the appearance of the butterflies imitated. It would almost appear from this that the Nymphalide imitators stood in need of a more complete protection than the mimicking *Papiliones*; and I find that, in general, they are comparatively fewer in individuals than the latter.

The following Table exhibits a view of the more striking cases of mimicry that have come under my notice, and also indicates the localities in which each model and its copies are known to occur together:—

Tabular View of the most remarkable Mimetic Analogies among African Rhopalocera, with the Localities in which the several Species concerned in each case are known to co-exist.

Danaidæ.	Nymphalidæ.	Papilionidæ.		
Danais Damocles Angola.	Diadema Damoclina, n. s. Angola.			
Danais Egialea Sierra Leone. Ashanti.	Diadema dubia. Sierra Leone. Ashanti.			
Danais Echeria		Papilio Merope ♀ (1st form *Cenea*, Stoll).	Papilio echerioides, ♀	
Type Knysna, Cape Colony. Bashee River, Kaffraria. Port Natal.		Type Knysna, Cape Colony. Bashee River, Kaffraria. Port Natal.	Var. Tsomo River, Kaffraria.	
Var. Knysna. Bashee River. Port Natal.	Diadema mima, n. s. Port Natal.	Var. Port Natal.	Type. Tsomo River. Natal.	Papilio Leonidas. Var. austr. (Brasidas, Felder). Bashee River. Port Natal.
Danais Niavius	Diadema Anthedon	Papilio Merope ♀ (2nd form *Hippocoon*, Fab.).		
Type Sierra Leone. Ashanti.	Type Sierra Leone. Ashanti.	Type. Sierra Leone. Ashanti.		
Var. austr. Port Natal.	Var. austr. Port Natal.	Var. austr. Port Natal.		
Danais Chrysippus	Diadema Bolina ♀	Papilio Merope ♀ (3rd form, *Trophonius*, Westwood).		
Type. Sierra Leone. Ashanti. St. Helena. Damara-land. Bechuana-land (Motito). Transvaal (Potchefstroom). Cape Town, Knysna, Plettenberg Bay } Cape Colony. Bashee River. Umquabaaba, D'Urban, Pietermaritzburg } Natal. St. Lucia Bay. Madagascar. Bourbon. Mauritius. Zambesi. Somauli-land.	Type. Sierra Leone. Ashanti. St. Helena. Damara-land. Bechuana-land (Motito). Transvaal (Potchefstroom). Cape Town, Knysna, Plettenberg Bay } Cape Colony. Bashee River. Umquabaaba, D'Urban, Pietermaritzburg. } Natal. St. Lucia Bay. Madagascar. Bourbon. Mauritius. Zambesi. Somauli-land.	Knysna. Plettenberg Bay. Bashee River.		
Var. *Alcippus*, Cr. Sierra Leone.	Var. Sierra Leone.			
Var. *Dorippus*, Klug. D'Urban, Natal.	Var. *Inaria*, Cr. D'Urban, Natal.			

* *Diadema Bolina* is a notable exception.

Table (continued).

Acræidæ.	Nymphalidæ.	Eurytelidæ.	Papilionidæ.	
Acræa Gea ♂ and ♀	Panopea Hirce ♂ and ♀	Melanitis Phegea	Papilio Cynorta ♀	
Sierra Leone.	Type.	Var. ♀ (*Bammakoo*, Westw.)	(*P. Boisduvallianus*,	
Ashanti.	Ashanti.	Ashanti.	Westw.)	
Calabar.	Calabar.		Sierra Leone.	
Acræa Euryta	Panopea Hirce	Melanitis Phegea.	Ashanti.	
Var. ♀	Var. ♀.		Calabar.	
Calabar.	Calabar.			
Var. ♀	Var. ♀.			
Congo.	Congo.			
Var. ♀	.....	♀♂.		
Congo.				
Var. ♀	.....	♀.		
Acræa Aganice ♂	Panopea Tarquinia, ♂.			
Port Natal.	Port Natal.	Calabar.		
Acræa Lycoa.....	Panopea Lucretia.			
Sierra Leone.	Sierra Leone.			
Calabar.	Calabar.			
Acræa Zetes ♂ and ♀	Panopea Boisduvalii.			
Type	Type.			
Ashanti.	Ashanti.			
Calabar.	Calabar.			
Var. austr.	Var. austr.			
Port Natal.	Port Natal.			
Acræa Egina ♂ and ♀	.....	.....	Papilio Ridleyanus ♂	
			and ♀.	
Congo.			Congo.	

In order to give a clear idea of the nature of these cases of mimicry, it is necessary to consider them separately. I will therefore describe them *seriatim* as concisely as possible, only premising that, as regards Tropical Africa, so little is on record respecting the range of individual species or their variation, to say nothing of habits and stations, that it is at present impossible to treat satisfactorily of the instances occurring in that immense tract of country.

1. Danais Damocles, Fab.

Danais Damocles, Ent. Syst. iii. 1. p. 41. no. 121; Palisot de Beauvois, Ins. Afr. et Am. Lep. t. 6. figg. 3 *a*, 3 *b*.

This species is rather widely spread in tropical Western Africa, examples having been received from Sierra Leone, Ashanti, the Gaboon, and Angola (in about 8° S. lat.). It is nearly related to *D. Egialea*, Cram., but is larger, and may be recognized by the broader central white band of the fore wings (which extends below the first median nervule), by the more irregular subapical white bar of the same wings, and by the smaller and whiter basal space in the hind wings. The Gaboon examples form a variety in which the pale basal patch in the hind wings is either reduced to a small spot or altogether absent. In Angola this *Danais* is accompanied by a *Diadema* (which also inhabits Congo) that very closely imitates it, differing from *Diadema dubia*, its nearest ally*, precisely as *Danais Damocles* differs from its congener *Egialea*. The two species

* I propose for this butterfly the name of

Diadema Damoclina, n. sp.

Exp. 3 in.–3 in. 5 lin. Closely allied to *D. dubia*, Pal. de Beauv. *Fore wing*: central white bar much broader,

of *Danais* appear to exist side by side at Sierra Leone and in Ashanti; and it is probable that the mimickers of *Damocles* will eventually be found in those localities from which *Diadema dubia* has already been brought.

2. Danais Egialea, Cram.

Danais Egialea, Pap. Exot. pl. 192. fig. D.

This *Danais* has apparently a less extensive range than *D. Damocles*, inhabiting Sierra Leone, Cape Palmas, and Ashanti. It is most exactly copied by *Diadema dubia*, Pal. de Beauv., the only noticeable difference being that the *Diadema* has three or four additional dots near the hind margin of the hind wings. There are specimens of this *Diadema* in the British Museum, from Sierra Leone and Ashanti; and in Mr. Hewitson's collection, from Calabar. Palisot de Beauvois records it as a native of Oware and Benin, the latter district being situated between Ashanti and Calabar.

3. Danais Echeria, Stoll. (Tab. XLII. figg. 3, 7.)

Danais Echeria, Suppl. Cramer, Pap. Exot. t. 29. figg. 1, 1 *a*.
—— *Vaillantiana*, Godt. Enc. Méth. ix. p. 183. no. 25.

D. Echeria is a widely-spread and abundant butterfly throughout the wooded parts of South Africa, where it takes the place of its tropical ally, *D. Egialea*. Like the latter, it has an exact imitation in a *Diadema*, which, though nearly allied to *D. dubia*, appears to be distinct*. But *Echeria* has no less than three other imitators in the genus *Papilio*, the two more accurate mimickers—*P. echerioides*, Trimen, ♀, and *P. Merope*, Cram., ♀ (= *Cenea*, Stoll)—being females of very dissimilar males, and the third a variety of *P. Leonidas*, Fab., which seems only to occur in South Africa beyond the tropic, and in which the pale markings are almost or wholly devoid of the green or greenish colouring of the type-form, and several of the lesser spots generally wanting. All these mimicking species are much rarer than the *Danais*—especially the *Diadema*, of which I met with only two examples in Natal, and have seen but five others in collections. *Papilio eche-*

continuous, not interrupted on median nervure; subapical bar interrupted, narrower, more macular. *Hind wing*: whitish basal space reduced to a small ovate marking, occupying discoidal cell (and extending beyond and above it), well defined, instead of gradually fading into the ground-colour; the submarginal white spots much smaller, some of them occasionally wanting; ground-colour darker than in *D. dubia*. Underside.—As in *D. dubia*, but with the white bars differing in the same manner as on the upperside.

Hab. Angola.

In the collection of the British Museum.

* I append a diagnosis of this species:—

Diadema mima, n. sp. (Tab. XLIII. fig. 7.)

Exp. 3 in. 7 lin.–3 in. 8½ lin. Nearly allied to *D. dubia*, Pal. de Beauv. *Fore wing*: white spot next base, in discoidal cell, much smaller, or nearly obsolete; subapical white band narrower, and distinctly composed of three spots; white spots of submarginal row smaller; no trace of ochreous scaling on inner margin. *Hind wing*: pale central space broader, uniformly yellow-ochreous. Underside.—Differs similarly from that of *D. dubia*: white spots at bases of wings smaller. *Fore wing*: the bluish edging of the larger markings entirely wanting. Sexes similar.

Hab. Natal.

In the Collections of the South-African Museum, W. C. Hewitson, and R. Trimen.

rioides is rather local than scarce, only occurring in woods at a considerable elevation; and, from Mr. Bowker's observations in Kaffraria, the ♀ would seem to be little, if at all, rarer than the ♂, though, in the only Natalian *habitat* in which I found the species tolerably common, the females were very much scarcer than individuals of the opposite sex. As regards the ♀ *P. Merope**, however, I have no doubt of its comparative rarity, as one may take males abundantly in the forests for days together, without once meeting with a female.

The resemblance to *Echeria* presented by the austral variety of *Papilio Leonidas* (*P. Brasidas*, Felder, Spec. Lep. p. 19, no. 249), appears in the cabinet but a slight one in comparison with the striking imitations just mentioned; but it is a fair-enough likeness in nature, especially when the insect settles †. Certain specimens (usually, but not invariably, females), which have the spots of the fore wings reduced in number and diminished in size, are much more like *Echeria* than others; and, looking at the insect in comparison with the type *Leonidas* of Western Africa (which resembles no known *Danais*), I have no doubt that the southern form has been, and is probably still being gradually modified in the direction of the dominant southern *Danais*.

Danais Echeria presents two varieties as regards the colour of the pale spots in the fore wings—one (the type) in which those spots are ochre-yellow (fig. 3), and the other in which they are white (fig. 7). The former is the prevalent form in the Cape Colony, and the latter in Natal; but I have taken both forms in each Colony, as well as intermediate examples in which the spots near the costal margin of the fore wings are white or whitish, while the rest are yellow. The *Cenea*-form of the ♀ *Papilio Merope* mimics both these varieties, and offers corresponding intermediate specimens; while the ♀ *P. echerioides*, which only inhabits the eastern portion of South Africa, almost always resembles the white-spotted variety, though I have seen, too, unusually small specimens which copy the yellow-spotted *Echeria*.

With reference to *Papilio Merope*, I think it well in this place to offer some observations on what I believe to be a remarkable instance of polymorphism in the ♀ of this species. First figured by Cramer (in 1779 and again in 1782), *P. Merope* has long been known as a native of Western Africa, and more recently as also inhabiting Southern Africa and Madagascar ‡. Its coloration is very conspicuous, and unlike that of any other *Papilio*, the upper surface being uniformly pale sulphur, or creamy-yellow, the fore wings with a narrow costal and broad hind-marginal black border, and the hind wings (which are tailed) having a more or less broken black band across the disk, and some black hind-marginal lunules. The Felders, in their 'Species Lepidopterorum' (1864), have separated the single species generally recognized into three, viz. (in addition to the type *Merope*) *P. sulphureus* of Palisot de Beauvois (figured by that author

* The various forms of the ♀ *Merope* will be discussed further on.

† *P. Leonidas* has the habit (rare in a *Papilio*) of settling not unfrequently on the projecting twig of some tree, and there remaining motionless, with the wings closed and hanging downward, precisely after the manner of *Danais Echeria*, for which species, in this position, I have, on more than one occasion, mistaken it.

‡ Mr. Horace Waller has shown me a specimen taken at Mount Morambala, on the River Shiré, a northern tributary of the Zambesi.

from a West-African specimen) and *P. Meriones*, n. sp., the Madagascarene form, or "Var. B," of Boisduval's 'Spécies Général' (p. 222). The former of the two Felderian species appears to me of doubtful value, being founded upon some slight differences in the outline of the wings (a very variable character in *Merope*) and in the width of the discoidal cell of the hind wings*; but there is some ground for the separation of the form inhabiting Madagascar, as will be seen immediately.

Considering for how long a time this fine *Papilio* has been known, and how frequently it reaches England in collections from the various African settlements, it seems singular that the female should be unknown. I have examined a large number of specimens in the National Collection, the Oxford Museum, and the principal private collections, and found them, without exception, to be males. In Southern Africa, I have been familiar with the butterfly in its native woods for some years, have taken some scores of specimens, and have examined many others from localities which I had no opportunity of visiting: all were males.

But in various parts of the Cape, Kaffraria, and Natal there occurs, within a range corresponding to that of *P. Merope*, the uncommon *Papilio Cenea*, of Stoll, already mentioned as so singularly accurate a mimicker of *Danais Echeria*. I have reason to believe that nearly all the specimens of this at present in collections have passed through my hands; and among the whole number (about 25) from various localities, no male has occurred. A black *Papilio*, without tails†, and marked with ochre-yellow patches and spots, is a very different-looking butterfly from the fine pale-yellow *Merope*; yet there is good reason for believing that *Cenea* is the female of *Merope*, modified in imitation of *Danais Echeria*. A close inspection reveals many points in common between the two insects. The head, thorax, and abdomen are similarly coloured and spotted. The pale spot near the apex of the fore wings, so conspicuous in the dark border of *Merope*, is almost always present (though occasionally smaller) in *Cenea*. On the under surface, the ochre hue of the hind wings and border of the fore wings only differs in *Cenea* by being rather darker; and the cellular and internervular streaks in the basal region, as well as a pale space, between the radials, in the darker band beyond the middle of the hind wings are found in both butterflies. Both in the Cape Colony and Natal, the woods in which *Merope* was common were the only spots in which I met with *Cenea*; and on one occasion I saw *Cenea* chased by *Merope* in the manner peculiar to a male butterfly when in pursuit of the female. Apart from these circumstances, analogy with the case of *Papilio echerioides* (the ♀ of which also copies *Danais Echeria*, while the ♂ is widely different) strongly supports the probability of the view here enunciated.

As *Cenea* occurs only in the south of Africa, its known range being from Knysna

* Dr. Felder does not use the name *sulphureus* to include the West-African form of *Merope*, expressly observing (*loc. cit.* p. 77) that the agreement of Cramer's figures, made from West-African examples, with the South-African *Merope*, precludes him from considering *sulphureus* a geographical subspecies.

† Cramer's earlier figures (pl. 151. figs. A, B) represent *Merope* without tails. This may be, as Boisduval suggests, only the result of mutilation; but these processes are known to be a variable character in many species of *Papilio*, and in *Merope* itself vary in size; so that the existence of a form in which they are wanting, or nearly so, need not be thought impossible.

(lat. 33° 59′ S., long. 23° 3′ E.) to Port Natal, the inquiry naturally arises, where is the female of the tropical *Merope*? One might have been at a loss here, were it not for another, and still rarer, isolated ♀ *Papilio* which is found in Southern Africa, viz. *P. Hippocoon*, Fab. (=*P. Westermanni*, Boisd.), and which appears to be rather commoner on the western coast. This butterfly closely resembles *Danais Niavius*, Linn., a common species, which also inhabits tropical Africa and Natal. *Hippocoon* is brought from the same localities as *Merope* in Western Africa, but is very much scarcer in collections. The markings already mentioned as common to *Merope* and *Cenea* recur in *Hippocoon*; and some remarkable intermediate southern examples in my collection appear to indicate some of the stages by which *Hippocoon's* broad white markings may have been gradually modified in the direction of the dominant southern *Danais*, *D. Echeria*, until so different a form as *Cenea* was the result. In various collections, I have examined fourteen specimens of *Hippocoon*, all of which are females.

A third remarkable *Papilio* must be placed as another form of the ♀ *Merope*, viz. *P. Dionysos*, Doubl.*, a very rare insect inhabiting Western Africa. I had long regarded this butterfly as probably connected with the curious series of forms under consideration, even when I knew it only from the figure in the 'Genera of Diurnal Lepidoptera;' and my opinion has been strengthened by an examination of the type specimen in Mr. Hewitson's collection †. That example, as well as another larger specimen recently received by Mr. Hewitson from Old Calabar, is a female. These two specimens come nearer to *P. Hippocoon* than to any other butterfly; but their colouring is very singular, the larger white space of the fore wings extending the whole length of the inner margin, and being scarcely separated from the subapical white bar by some blackish scaling, while the hind wings are wholly warm yellow-ochreous, except the white-spotted black hind-marginal bordering. On the underside, however, the dull ochre margins of the wings, and the internervular streaks, are like those of *Hippocoon*; and the apical spot in the fore wings, as well as the markings of the body, present no difference. But the strongest proof of the most intimate affinity between the two forms is afforded by a third female specimen, which accompanied that just mentioned from Old Calabar; for in this example the characters of *Hippocoon* and *Dionysos* are unmistakably blended, the markings of the fore wings being precisely those of the former (except that the inner marginal white extends rather further into the wings), while the yellow tint of the hind wings, though paler, is like that of the type *Dionysos*.

The fourth form of the ♀ *Merope* is that described and figured by Professor Westwood ‡ under the name of *Papilio Trophonius*, and suggested by him as possibly the female of *P. Cenea* §. In this form the markings quite agree in size and shape with

* Gen. Diurn. Lep. pl. 3. fig. 4.

† I take this opportunity of recording my warmest acknowledgment of the courtesy and liberality with which Mr. Hewitson has given me unlimited access to his fine collection. I am also indebted to Mr. Bates, Mr. Butler, Mr. Salvin, Mr. Wallace, and Professor Westwood for similar kind assistance.

‡ Arcana Entomologica, i. p. 163, pl. 39. figs. 1, 2.

§ This view of the sexes was adopted by Doubleday, without query, in the 'Genera of Diurnal Lepidoptera;' and upon this authority I unfortunately, without investigation, perpetuated the error in Part I. of my 'Rhopalocera

those of the southern examples of *Hippocoon*; but the hind wings and the broad inner-marginal space in the fore wings are coloured *brick-red* instead of white; and the butterfly thus becomes a very fair imitation of *Danais Chrysippus* *. This form of ♀ is even rarer than *Hippocoon*, the number of specimens that I have seen in collections being seven only, including two that I had the good fortune to capture in the Cape Colony, one at Knysna, and the other at Plettenberg Bay †. Professor Westwood (*loc. cit.*) states that *Trophonius* is a native of Guinea as well as Kaffraria.

We have thus, as it appears to me, a most remarkable case of polymorphism in the female of *Papilio Merope*—three of the four forms being direct mimickers respectively of three prevalent African species of *Danais*, while the fourth, differing from all the others, yet closely related by an intermediate variety to one of them, is probably modified, or in course of modification, in mimicry of some other protected butterfly, possibly not a *Danais* ‡.

But another point remains for consideration. *Papilio Merope* (or its close ally) in Madagascar, presents a female *tailed and coloured like the male*, and differing only in the possession of a broad black bar on the costa of the fore wings, almost crossing the discoidal cell. That this is the rule in Madagascar cannot be doubted, as Mr. Plant's collection contained a series of females presenting little or no variation. The examination of a number of examples from the island in question leads me to think that the form there prevalent is constant in both sexes, and entitled to rank as a distinct species §. But whether we accord or refuse specific rank to *P. Meriones* matters little to those who hold that unmistakably close alliance between two or more forms is at once the result and evidence of community of descent. Place the males from the island side by side with those from the continent of Africa, and perhaps few would be disposed to regard the former as specifically distinct from the latter; and yet we find the female of

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Africæ Australis,' published in 1861. Hopffer has recently (Stett. ent. Zeit. 1866, pp. 131–132) corrected the mistake, pointing out that females of both forms are in the Berlin Museum.—*Vide* 'Zoological Record' (1866), p. 451.

* A curious example, taken (in company with *P. Merope*) near St.-Lucia Bay in South-eastern Africa, by Col. Tower, of the Coldstream Guards, is to some extent intermediate between the *Trophonius* and *Hippocoon* forms, the broad whitish spaces being obscured throughout with a dull-ochreous tint.

† It is worthy of notice that on each occasion of my meeting with *Trophonius*, I took, in the same spot, a specimen of the *Cinea* form of ♀.

‡ It may be objected that, in the strict sense of the term, this is not a true case of polymorphism, seeing that intermediate varieties still occur which more or less connect the different forms. I am willing to admit that the phenomenon is not yet absolutely complete; but the three forms that imitate the three species of *Danais* are already so marked that the elimination of the few individuals of intermediate or unstable character, that serve to link to some extent two or more of those forms, will probably be the work of no very extended period.

§ In the insular form, the black border of the *fore wings* forms much sharper projections inwardly on the nervules, and the costal edging is brownish instead of black, in the ♂ never extending below the subcostal nervure. The band crossing the *hind wings* is always widely interrupted in two places, and the intermarginal black edging is wanting, while the tails are all fuscous except the broad ochreous tip. On the *underside*, the ochreous colouring is rather paler and more rufous in tint; and in the ♀ the *hind wings* are clouded from the base, over the disioidal cell, and the inner-marginal region with brownish. The spots of the head and thorax are yellowish, and in the ♂ almost concealed by a clothing of brownish hairs; and the abdomen is without the ordinary dark spots (save some very faint traces in the ♂), being coloured almost uniformly of the same pale yellow as the upper surface of the wings.

the insular race constant to one pattern, and not differing greatly from the male; while the African female presents four distinct forms (besides certain intermediate varieties), not one of which resembles the male. It would appear reasonable to argue from this that Madagascar was the original starting-point of this type of *Papilio*, and that the harder and more complex conditions of African life, causing a severer persecution, had occasioned a necessity for the less active, and perhaps, as now, scarcer ♀ to assume the protective colouring and outline of the surrounding *Danaidæ*. Yet the very wide dispersion of this butterfly over the continent seems rather to indicate that the original form of *Merope* was of African derivation, and at one time had extended to Madagascar, possibly before that region became insulated, but that since that period, during slowly-changing conditions of life, natural selection has induced the elimination in Africa of all the pale, conspicuous females of the male coloration, only preserving those that more or less resembled the protected *Danaidæ*,—while in Madagascar the female, in the absence of any keenly persecuting agency, has retained the form and colour possessed by the first immigrants from the continent. In the broad black costal bar of the fore wings which distinguishes the female in Madagascar, regarded in relation to the hind-marginal black border, it is not difficult to recognize the material upon which natural selection might gradually work, to the ultimate production of a Danaidiform butterfly like *Hippocoon* or even *Cenea*; and it is remarkable that, in all the African forms of the female, an oblique, narrow, whitish marking remains near the extremity of the discoidal cell of the fore wings, in a position exactly corresponding to the outer border of the costal bar, as if to record, with the other pale spots and markings, how the black of the margins had gained upon the ground-colour as the process of increasing resemblance to *Danais* was slowly wrought out.

Returning to the subject, from which this has been so lengthy a digression, it is worthy of note that the mimicking *Diadema* above described seems only to occur at Natal, and correctly copies the variety of *Danais Echeria* which is there prevalent, viz. that which has all the spots of the fore wings white.

4. Danais Niavius, Linn. (Tab. XLII. fig. 6.)

Danais Niavius, Syst. Nat. ii. p. 766. no. 109 (1767); Cram. Pap. Exot. t. 2. figg. E, G.

This is an abundant butterfly in Tropical Western Africa; but the only special localities that I have found recorded for it are Sierra Leone, Ashanti, and Angola. In the two former of these districts occur two very accurate imitators of *Niavius*, viz. *Diadema Anthedon*, Doubl., and the prevalent West-African form of the ♀ *Papilio Merope* (*P. Hippocoon*, Fab.). The *Papilio* has also been received from Calabar.

It is to this striking case of mimicry that Boisduval refers in the passage which I have quoted at the head of this paper. He mentions, it is true, *Diadema dubia*; but this is owing to the confusion that has prevailed regarding the closely allied mimetic *Diademæ*, *D. Anthedon* being the species concerned, and being easily distinguished by the very large inner-marginal white patch, and broad subapical bar of the fore wings. Cramer, as Prof. Westwood has pointed out (Arc. Ent. i. p. 152), figured the *Papilio* as the ♀ *Niavius*, in his Plate 234. fig. A; and Palisot de Beauvois subsequently did the same

(Ins. recueillis en Afrique, &c. t. vi. figs. 1 *a*, 1 *b*). *Danais Niavius* is not confined to West Africa, but also inhabits Natal, where it constantly presents broader white markings, particularly in the hind wings * ; and it is most interesting to find that both the *Diadema* and the *Papilio* in that part of Africa vary in exactly the same manner from the tropical type-form. *Diadema Anthedon* † has been taken at St. Lucia Bay by Col. Tower, and is recorded from the Querimba Islands by Hopffer (in Peters's 'Reise nach Mossambique,' p. 385); and there can therefore be little doubt of its occurrence in company with *Niavius* in the intermediate Zambesi region.

I did not find this *Danais* commoner than the *Diadema* at Natal, during my visit in the early part of 1867; but Mr. M'Ken, the Superintendent of the Botanic Gardens at D'Urban, informed me that it was more plentiful at another season of the year. So close is the resemblance between this butterfly and *Diadema Anthedon* on the wing, that I was never certain as to which butterfly I had captured, until close examination had been made. The *Hippocoon*-form of the ♀ *Papilio Merope* seemed very rare at Natal, one example only being taken, by my Kafir collector, near D'Urban. As far as my present knowledge extends, however, this form of the female *Papilio* appears to range further southward than either the *Danais* or the *Diadema*; for I have seen two examples captured in Kaffraria proper by Mr. J. H. Bowker, and another taken near Grahamstown by Mrs. Barber. The ♂ *Papilio Merope*, it should be observed, as well as the *Cenea*-form of ♀, occurs in both those localities, and as far to the south and west as the Knysna River.

5. DANAIS CHRYSIPPUS, Linn. (Tab. XLII. fig. 5.)

Danais Chrysippus, Syst. Nat. ii. p. 767; Cram. Pap. Exot. t. 118. figg. B, C.
Var. A. *Alcippus*, Cram. *op. cit.* t. 127. figg. E, F.
Var. B. *Dorippus*, Klug, Symb. Phys. pl. 48. figs. 1–5.

This well-known species seems to inhabit the whole of Africa, ranges through southern Asia from Syria to Hongkong, and is recorded from Java, Ceram, and Timor, in the Malayan Archipelago. It even extends into Southern Europe (Greece and Turkey), and, according to Godart, has been taken at Naples. It presents two varieties,—one (*Alcippus*, Cr.) in which the disk of the hind wings is more or less suffused with white; the other (*Dorippus*, Klug) in which the black apex of the fore wings, and its oblique white bar, are obliterated by the brick-red ground-colour ‡. Both these varieties seem to be most frequent in Africa, *Alcippus* being known from four, and *Dorippus* from three different parts of that continent. It is needless to dwell upon the very striking

* An example of this southern variety was brought from the Zambesi by the Rev. H. Rowley, and is now in the Hope Museum at Oxford.

† In my 'Rhopalocera Africæ Australis,' pt. ii. p. 338, I have given *Anthedon* as a synonym of *dubia*. This is an error, into which I was led, in the absence of specimens of *dubia*, by Boisduval's description (Faune Ent. de Mad. &c. p. 40), and by his mention of *dubia* as having a special analogy with *Danais Niavius*.

‡ The type of Klug's *Dorippus*, figured in 'Symbolæ Physicæ' (*loc. cit.* figs. 1–4), consists of examples of both sexes, from New Dongola and Ambukhol, on the Nile in Lower Nubia, which present both the red suffused apex of the fore wings and a broad white suffusion over the disk of the hind wings. The "variety" of the male, however (fig. 5), wants the white in the hind wings, but has a dull fuscous shade over the basal half of both wings.

resemblance borne to *Danais Chrysippus* by the female *Diadema Bolina*, Linn., as this is one of the most generally known cases of mimicry in existence. The *Diadema* accompanies the *Danais* throughout its range, with the single exception of the European shore of the Mediterranean—and is even recorded from Australia and South America *, regions in which *Chrysippus* does not occur. It is very seldom that one receives a collection, however small, containing *Chrysippus*, in which *Bolina* is absent. I have been careful to note all the recorded localities of specimens of both butterflies that have come under my notice, and find that the two coexist in twenty-two different localities, in addition to which there are seven instances of their occurrence in closely adjacent districts †. Still more interesting is the fact that the ♀ *Diadema* presents two varieties exactly corresponding with the varieties of *Chrysippus* mentioned above, viz. one in which the hind wings are more or less clouded with white, and another (*Inaria*, Cram.) that has the apical black and white of the fore wings replaced by the brick-red ground-colour ‡. In each of these cases, I have not succeeded in finding more than one locality where the variety of *Chrysippus* is known to be accompanied by the corresponding variety of *Bolina*, viz. Sierra Leone, where the white-clouded form of both butterflies occurs, and D'Urban, Port Natal, whence I have both *Dorippus* and *Inaria*; but there seems little reason to doubt that they are to be found together in many other places, when we consider how widely the varieties of both insects range.

In nature, the imitation of *Chrysippus* by the ♀ *Bolina* is singularly deceptive, as well when the butterfly is settled on flowers as when it is on the wing; and it requires a keen eye and close observation to distinguish one insect from the other. I am disposed to imagine that the closeness of the mimicry even deceives the male *Chrysippus*; for, on one occasion, at Port Natal, in a spot where the *Danais* was abundant, I was for some time watching two females of *Bolina* that I had carefully marked, and was as much surprised as interested to observe a *Chrysippus* pertinaciously chase one of the *Bolinæ* about the place. The female *Diadema* naturally gave *Chrysippus* no encouragement, and, being more active on the wing, repeatedly evaded her pursuer §. Waiting to see the close of this singular chase, I unfortunately lost sight of the *Chrysippus* among the other specimens floating about; but I captured the ♀ *Bolina*, and have no doubt that the pursuer was of the male sex.

I have already noticed the rare form of the female *Papilio Merope* (*P. Trophonius*, Westw.), which mimicks *D. Chrysippus*. This imitation is not by any means as close

* Regarding the latter region, it seems to be doubtful whether *D. Bolina* has succeeded in naturalizing itself in any of the localities mentioned by authors; but the insect certainly appears to have been taken in Guiana (Boisduval and Doubleday), Surinam (Cramer and Boisduval), Cayenne (Godart), and Pará (Hopffer).

† Even in the oceanic islands to which *Chrysippus* extends, such as St. Helena (Coll. Burchell), Bourbon, and Mauritius, *Bolina* appears as its constant companion; but I have not heard of the latter's occurrence in Teneriffe, where *Chrysippus* has been taken.

‡ Similarly to Klug's type of *Dorippus*, the *Inaria*-form of the ♀ *Bolina* is sometimes found with a white suffusion on the hind wings.

§ The ♂ *Bolina*, when pursuing the female, keeps a little below her, with his wings constantly and rapidly quivering, while the female slowly rises, with little motion of the wings, towards the summit of some adjacent tree. Mr. J. H. Bowker observed this in Kaffraria, in the year 1863; and I have since noticed he same in Natal.

as that by *Diadema Bolina*, but it is sufficiently near to deceive the collector when the butterfly is on the wing. Until they settled on flowers, when the tremulous motion of the wings at once betrayed their disguise, I mistook both the examples of this *Papilio* that I captured for *Chrysippus*.

In Western Africa (Ashanti) occurs a fine Nymphalide, *Romaleosoma Eleus*, Dru., the colouring and pattern of the female of which show a strong, but far from exact resemblance to those of *D. Chrysippus*, the principal element of difference being the possession by *Eleus* of a broad black band, containing conspicuous white spots, which borders the hind wings. There is, however, in the British Museum, a variety of the ♀ *Eleus*, from Congo (in 6° S. lat.), which more nearly approaches the aspect of *Chrysippus*. Compared with the type-form, it is smaller, and with more elongated fore wings; the ground-colour is redder and clearer; the apical black of the fore wings occupies a smaller space, while its white bar is broader; and the border of the hind wings is narrower, though still broad and conspicuous*. Congo is one of the known *habitats* of *Chrysippus*.

6. Acræa Gea, Fab.

♂ *Papilio Gea*, Fab. Sp. Ins. ii. p. 32.
P. Epea, Cram. Pap. Exot. pl. 230. figs. B, C.
♀ *Papilio Iodutta*, Fab. Ent. Syst. iii. 1. p. 175.
♂, ♀. *Acræa Gea*, Godt. Enc. Méth. ix. p. 238.

I have no doubt that Godart rightly considered the *Iodutta* of Fabricius to be the ♀ of that author's *Gea*, as the difference in colour of the pale bands is the only distinction, and there are several instances of allied *Acrææ* in which the fulvous or yellow markings of the male are replaced by white in the female. Doubleday ('Gen. Diurn. Lep.' p. 141) gives the *Timandra* of Jones's 'Icones' as the female of *Gea*, while Godart refers it to *E. Euryta*, Linn. The specimens named *Timandra* in the National Collection agree well with Fabricius's description of *Iodutta*, and are evidently females of *Gea*.

The male has been received from Ashanti, Calabar, and Congo; the female from Sierra Leone and Calabar. Two other butterflies inhabiting both Ashanti and Calabar are close mimickers of this *Acræa*, viz. *Panopea Hirce*, Dru., and the female *Papilio Cynorta*, Fab. (= *P. Boisduvallianus*, Westw.)†. In the *Panopea*, the imitation is twofold, the differing male and female of the *Acræa* being copied by the corresponding sexes of the mimicker; but in the *Papilio* it is the female only that copies (very exactly) the female *Gea*, the male being of a very different pattern as regards the fore wings. In addition to

* *Danais Chrysippus* is not without its mimickers among the eastern *Nymphalidæ*, the most remarkable of which are the Javan *Cethosia Penthesilea*, Cr., and the female of *Argynnis Niphe*, Linn., inhabiting India and China. The *Cethosia* differs widely from *Chrysippus* on the under surface, but the upperside is a very close copy, both in pattern and colours, of that of the *Danais*, differing only in the possession of a submarginal row of spots in the hind wings. The case of the ♀ *Argynnis* is the more interesting from the fact of the sexes being so dissimilar, the male being of the ordinary colouring of the genus.

† I have elsewhere discussed the grounds for considering *P. Boisduvallianus* to be the female of *Cynorta* (see Trans. Ent. Soc.).

the localities named, the *Papilio* has also been found at Sierra Leone and the Gaboon, at the former of which places the *Acræa* occurs.

There is a difference in the outline of the wings between the male and female of *Acræa Gea*, as in many other species of the same genus; and this discrepancy is reproduced in *Panopea Hirce*, the female of which has the fore wings blunter and broader than those of the male. So deceptive is the mimicry of the ♂ *Gea*, by the ♂ *Hirce*, that Godart (*loc. cit.*) quotes Drury's figure of the latter as a representation of the *Acræa*. In the Linnean collection there is a specimen of the *Panopea* labelled "*Acræa Gea*, Fab."; and I found an example associated with a specimen of the same *Acræa* in the Banksian Collection at the British Museum. The figure of "*Euryta*" in Clerck's 'Icones' (t. 31. f. 180), to which Linné refers in the twelfth edition of the 'Systema Naturæ,' is evidently drawn from a female of the same *Panopea**.

This species of *Panopea* further presents several varieties of the female, which agree with no known examples of *Acræa Gea*, but, strangely enough, are very fair imitators of certain varieties of an allied species, *A. Euryta*, occurring in the localities (Calabar and Congo) which they inhabit†. In the British Museum there is an interesting specimen of the female *Hirce*, in which the bands, though paler, are coloured like those of the male. This example only bears the label "West Africa," and I am therefore unable to state whether this apparently rare form of the female occurs in company with that which is white-banded.

Most of the examples of *Melanitis Phegea*, Fab., a member of the *Eurytelidæ*, are mimickers of *Acræa Euryta*; but a female specimen, from Ashanti, in the National Collection (which is, I believe, the type of *M. Bammakoo*, Westw. Gen. D. Lep. pl. 68. f. 3) bears a nearer resemblance to the female *A. Gea* in the position of the subapical bar of the fore wings, and in the extension of the white band of the hind wings over the inner margin of the fore wings.

7. Acræa Euryta, Linn.

Acræa Euryta, Syst. Nat. ii. p. 757. n. 69; Cram. Pap. Exot. pl. 233. figs. A, B.

This is a most variable species in both sexes. Mr. Hewitson has recently (October, 1867) devoted two plates of his 'Exotic Butterflies' to the delineation of the principal varieties‡. It is not unlikely that a knowledge of the stations and habits of these but-

* Mr. Butler, who kindly pointed this out to me, has suggested that the *Panopea* should stand as *P. Eurytus*, Clerck, this name being older than Drury's. But it seems clear that Clerck figured the insect in the belief that it was Linné's *Euryta*, which is an *Acræa*; and it thus appears to me desirable, especially with the view of avoiding confusion in names, to retain the appellation of *Hirce* for the *Panopea*. Linné's description, too, as Mr. Hewitson remarks ('Ex. Butt.' Oct. 1867), accords with the *Acræa*, notwithstanding that he quotes Clerck's figure.

† Mr. Hewitson, who has already, in his 'Exotic Butterflies' (part for October, 1867) delineated the varieties of *Acræa Euryta*, and in whose collection I saw these singular varieties of *P. Hirce*, is about to publish the latter also; and I therefore refrain from more particularly describing the imitations in question.

‡ After examining Mr. Hewitson's fine series of this butterfly, I am disposed to agree with him that it is at present impossible to separate the numerous forms which he has figured, with the exception of the female shown in the second plate, fig. 29, which appears to be a distinct species.

terflies would enable us to distinguish several local races, if not distinct species; but, with the scanty information at hand, the attempt to do so would prove of little value.

As already mentioned, certain varieties of this abundant *Acræa* (which is known to inhabit Sierra Leone, Ashanti, Old Calabar, the Gaboon, and Congo) are the objects of imitation by varieties of *Panopea Hirce*, ♀, received from Congo and Old Calabar. The particular varieties of the *Acræa* that are so imitated are known to inhabit the same localities as the mimickers.

Another imitator is the scarce Eurytelide, *Melanitis Phegea*, Fab. This butterfly, like others of its family, is marked on the underside of the wings with numerous short transverse lines; and it is interesting to observe how, at the base of the hind wings, several of these lines are confluently grouped, in manifest imitation of the spots which occupy the same position in the *Acræa*. The fulvous-marked examples of *M. Phegea*, of which I have seen two, appear to be males; but the variety of *Euryta* which they most closely resemble is a female, figured by Mr. Hewitson (*loc. cit.* f. 30), in which the fulvous bar of the fore wings is rather narrow and with an ochreous tinge, and the inner margin coloured with fulvous. The white-banded females of the *Melanitis* copy the ♀ *Acræa* figured on the same plate (f. 31), which has the band of the fore wings rather broader than usual, and that of the hind wings, with the inner margin of the fore wings, slightly tinged with yellow. *M. Phegea* has been brought from Old Calabar and Ashanti, as well as from other West-African regions not specially recorded.

8. Acræa Aganice, Hewits. (Tab. XLII. fig. 2.)

Acræa Aganice, Hewits. Exot. Butt. ii. pl. 6. f. 3; Trimen, Rhop. Afr. Austr. i. p. 109. n. 69.

This *Acræa* is closely related to *A. Euryta*, Linn., differing chiefly in the smaller size and distinct coloration of the male, which has the pale bands yellowish, or yellowish white, instead of fulvous. It is only known to occur in the South of Africa, inhabiting Kaffraria proper and Natal, and is accompanied in the latter district by a mimicking *Panopea*, which is nearly allied to *P. Lucretia*, Cram., and which I have recently described, in the Transactions of the Entomological Society of London, as *P. Tarquinia*. I mentioned (*loc. cit.*) the fact of this Nymphalide flying in the same woods with *Acræa Aganice*, and have noted its rarity*, and how completely in general appearance and habits it resembles its model. When, however, the insects are closely compared, the mimicry is not so striking, as the *Panopea* possesses an additional small whitish bar near the apex of the fore wings; but this is a subordinate feature, not noticeable when the butterfly is on the wing.

9. Acræa Lycoa, Godt.

Acræa Lycoa, Godt. Enc. Meth. ix. p. 239. n. 27.

A range of some extent is recorded for this *Acræa*, viz. Sierra Leone, Ashanti, Calabar,

* Since the paper referred to was written, I have seen two other examples of *Tarquinia* in Mr. Hewitson's collection—one from Natal, and the other from the Zambesi. The former of these has much yellower bands than those of the two that I met with in Natal, and evidently copies the yellower examples of *Aganice*.

and Congo. The species may at once be known from its allies by the peculiar pattern of the fore wings—the inferior pale marking running almost parallel with the subapical bar, and nearly to the posterior angle, instead of forming an inner-marginal space adjacent to the band crossing the hind wings. *Panopea Lucretia*, Cram., appears to mimic this *Acræa*; but the resemblance is not so accurate as that between *P. Tarquinia* and *A. Aganice*. Sierra Leone, the Gold Coast near Ashanti, and Calabar are the known localities inhabited by *P. Lucretia*, which seems as rare as *P. Tarquinia*, one specimen in the British Museum, two in Mr. Hewitson's collection, and two in the possession of Mr. Swanzy being all the examples that I have seen.

10. Acræa Zetes, Linn. (Tab. XLII. figs. 8, 9.)

Acræa Zetes, Syst. Nat. ii. p. 766. n. 110.
P. Menippe, Dru. Illustr. N. H. iii. pl. 13. f. 3, 4; Stoll, Suppl. Cr. Pap. Ex. pl. 28. f. 1.
Var. *Acræa Acara*, Hewits. Exot. Butt. iii. pl. viii. f. 14, 15.
Acræa Caffra, Felder, Reise der Novara, ii. p. 369, pl. xlvi. f. 10, 11.

North of the Equator, the type-form of this species has an extensive range on the western coast, but it does not appear to occur further to the south than Fernando Po. Specimens in various collections have been received from the island in question, as well as from Calabar, Ashanti, Cape Palmas, and Sierra Leone. In Southern Africa, the species is represented by a well-marked variety, *A. Acara*, Hewits.*, which differs, on the upper surface, in having all the markings of the fore wings strongly defined (the red ground-colour being wholly free from the almost universal fuscous suffusion so constant in the type), and in possessing a conspicuous subapical ochreous bar. Both in the type-form and in the southern variety, the colouring of the female is universally very much duller and fainter than that of the male.

From Old Calabar and Ashanti a rare and handsome Nymphalide, *Panopea Boisduvalii*, Doubl. (Gen. D. Lep. pl. 37. f. 3, ♀), which closely imitates the type *Acræa Zetes*, has been received. A male from the former district, in the collection of Mr. Hewitson, and a female from the latter, in the British Museum, are the only West-African specimens that I have seen; but these two examples respectively resemble in their differences the dissimilar male and female of the *Acræa*, the female exhibiting an incomplete subapical whitish ray, answering to that of the ♀ *Zetes*.

In Natal *Boisduvalii* reappears†, in company with, and evidently mimicking (in the red and black colouring of the fore wings and their ochreous subapical bar) the *Acara* form of *A. Zetes*; and here, again, each sex of the *Acræa* is copied by the corresponding sex of the *Panopea*. A singular example of the male *Panopea*, taken at Port Natal by

* *Acræa Caffra* of Felder. Mr. Hewitson notes (*loc. cit.*) that *Acara* is "perhaps only an extraordinary variety of *A. Menippe*."

† I have examined eight Natalian specimens in collections, five males and three females. Six of these were taken by Mr. M'Ken, the Superintendent of the Botanic Gardens at D'Urban, who has kindly contributed specimens to the South-African Museum and to my own collection, and who informed me that this beautiful insect is one of the rarest of the native butterflies, but haunts the same spots as *Acræa Zetes*. I saw but one individual (a female) on the wing during my stay in Natal, but did not succeed in capturing it.

Mr. M'Ken, and in the collection of the South-African Museum, is interesting from its entirely wanting the ochreous subapical bar of the fore wings, all the apical region being simply semitransparent fuscous grey (as in the tropical form), though the basal and inner-marginal region has the red ground and black spotting as conspicuous as usual in South-African specimens. This example thoroughly links the southern *Boisduvalii* with the West-African type-form, and seems to indicate that the process of assimilation to the southern form of the *Acræa* has not been fully completed.

Both sexes of the southern *A. Zetes*, but especially the male, exhibit a tendency to whitish suffusion about the discoidal cell and median nervules of the hind wings. Even this slight variation is imitated by the *Panopea*; for the only example, a male, brought from the Zambesi by the Rev. H. Rowley* has some faint whitish clouding in the same part of the hind wings; and a female from Natal, in the South-African Museum, is marked in the same manner.

It is not only on the upper surface that *Boisduvalii* successfully copies *Zetes*; the underside is very effectually imitated, as well as such Acræoid characters as the yellow palpi and the spotting of the thorax and abdomen. Even in outline (the female *Acræa* having less produced and blunter fore wings than the male) *Boisduvalii* is in both sexes a faithful imitator.

11. Acræa Egina, Cram.

Acræa Egina, Cram. Pap. Exot. pl. 39. f. F, G†.
A. Zidora, Godt. Enc. Méth. ix. p. 237.

The principal characters distinguishing this species from its near ally, *Zetes*, Linn., are as follows, viz.: in the *fore wings* the rufous marking near the posterior angle is much enlarged and conspicuous; the innermost of the three black spots in the discoidal cell, the customary ochreous marks along the hind margin, and the whitish-ochreous clouding beyond the costal black bar (all marked characters of *Zetes*) are wanting, and the costal bar itself is much narrower; while, in the *hind wings*, the black spots are larger, more numerous, and grouped nearer to the base, and there are no red spots in the hind-marginal border. These differences prevail in both sexes; but the ♀ is much duller and obscurer than the ♂, and with faint markings.

Like *A. Zetes*, *Egina* inhabits Sierra Leone and Cape Palmas; but it also occurs in Congo. From the latter region only there has been received *Papilio Ridleyanus*, White, a very rare butterfly‡, which, in pattern and coloration, stands alone in its great genus, though apparently belonging to the *Leonidas* and *Cyrnus* group. The likeness which this *Papilio* bears to *A. Egina* is very striking; and on the wing it must with difficulty

* This specimen is in the Hope Museum at Oxford, where Professor Westwood kindly pointed it out to me. I have not found *Acræa Zetes* recorded as a native of the Zambesi country; but the presence of *P. Boisduvalii* (of the southern form) renders it highly probable that *Zetes* inhabits that region.

† The *Egina* of Stoll (Suppl. Cramer, t. 25. f. c, 3 c) is distinct, being a smaller insect, with only a narrow reddish line along the inner margin of the fore wings and a very narrow black hind-marginal edging to the hind wings.

‡ I know of but three examples, viz. a male and female in the British Museum, and a male in Mr. Hewitson's collection.

be distinguishable both from that *Acræa* and from *A. Zetes*. I have been doubtful whether the *Papilio* better mimicked *Zetes* or *Egina*, but, on close comparison, believe the latter to be the special object of imitation, in consequence of the red discal band in the fore wings of *Ridleyanus* evidently copying the corresponding rufous space presented by *Egina*—though the red spots in the border of the hind wings resemble those of *Zetes*, and of *A. Perenna*, Doubl., a native of Ashanti*. The female *P. Ridleyanus* resembles the female *Egina*, not only in its coloration being much duller than that of the male, but (as in the case of *Panopea Boisduvalii* and *Acræa Zetes*) in the blunter, more rounded outline of the fore wings†.

The palpi of the *Papilio* are yellow, like those of the *Acræa*; and the hinder portion of the abdomen of the male is almost wholly yellowish beneath, and marked laterally with spots of the same colour, increasing in size to the extremity, so as to approximate to the colouring of the same part in the male *Egina*, while the paler and more distinct spots on the distended abdomen of the female present a nearer resemblance to the markings of the female *Egina*.

I have now passed under review the most remarkable instances, eleven in number, of mimetic analogies known to occur among the butterflies of Africa‡. It has been shown, (1°) that the mimicking butterflies invariably occur in districts inhabited by the species mimicked, and in six cases (of southern species or varieties) are found in the very same localities; (2°) that, in eight cases, the mimickers are known to be very much scarcer than the species which they copy; (3°) that, in five cases, where the *Danais* or *Acræa* presents local forms, or merely slight varieties, even these are imitated by individuals of the mimicking species; (4°) that, in three cases, where the sexes of the insect mimicked differ remarkably from each other, the sexes of the mimicker present corresponding differences; and (5°) that, in four cases observed by me in nature, it was next to impossible to distinguish the living mimicker from the species which it imitated. In the instance of *Danais Echeria*, I have demonstrated how, in addition to a *Diadema*, no less than three species of *Papilio* copy that butterfly, the two closer mimickers in *Papilio* being females of wholly dissimilar males, and belonging, in fact, to different sections of the genus! In the very remarkable case of the polymorphic *Papilio Merope*, it has been my endeavour to point out how three of the four forms of female in Africa are protected

* *A. Perenna* also has the rufous space near the posterior angle of the fore wings, but it is a considerably smaller insect than either *Egina* or the *Papilio*, and has the fore wings remarkably narrow and elongated.

† In the dull-fulvous suffusion of the hind wings, the ♀ *Ridleyanus* more resembles some female examples of *A. Zetes*.

‡ The vastness of the African regions that have never been entomologically explored renders it almost certain that many other equally striking cases of mimicry remain to be discovered. No part of Equatorial or even Tropical Africa has yet been searched by a competent lepidopterist—the collections transmitted to Europe from the western coast and other parts having been formed by persons who collected at random, with little, if any, care to record special localities or stations. Some idea of the Rhopalocerous riches of the region within a few degrees of the equator may be formed from an inspection of the third volume of Mr. Hewitson's 'Exotic Butterflies,' in which plate after plate is filled with figures of new species from Old Calabar, the fruit of the labours of a single collector, who, but for a short time and in a limited area, entomologized in that district.

by wearing the aspect, respectively, of three prevalent species of *Danais*; while the Madagascarene *Papilio Meriones*, so closely allied to *P. Merope* as to be regarded by most authors as merely a local race of the latter, presents but one form of female, not greatly differing from the male.

Such results as these, confirming and supplementing, as they do, the similar series of facts observed by Mr. Bates in Equatorial America, as well as those tabulated by Mr. Wallace in reference to India and the Malayan archipelago, are of the deepest significance. Inexplicable as they must ever remain when regarded on the theory of the independent creation of all organic beings precisely as we now behold them, they become clearly intelligible when viewed as the natural consequences of the innate variability of species, and the preservation and development by inheritance, through all time and under all changes of surrounding conditions, of every successive variation advantageous to the organism originating it. In the infinitely complicated "struggle for life," any advantage, however slight, inevitably has its effect; and the individuals possessing it will not only hold their ground to the exclusion of less fortunate competitors, but will transmit the precious quality to some at least of their descendants. The process by which natural selection gradually effects those innumerable protective resemblances of which these mimetic analogies among butterflies form but a small portion, has been so ably traced by distinguished naturalists, that it is unnecessary for me to attempt what could at best be but a repetition of arguments already adduced; but I may be permitted, in conclusion, to express my conviction of the harmonious relation in which the theory of the mutability and gradual origin of species stands in regard to what is now universally admitted respecting inorganic nature. No one disputes, at the present day, that the crust of the earth has undergone profound changes both structurally and chemically; but who is now found attempting to account for these mutations on the exploded theory of vast convulsions of nature or general cataclysms? It is conceded on all hands that the known forces and agencies at work under our eyes are sufficient, in the lapse of ages, to account for all the past changes, however stupendous, of which the records remain; but, with a strange inconsistency, any suggestion of gradual change in the incomparably more plastic and variable organic world is too often rejected with incredulity or disdain; and many men of science still cling to the theory of successive whosesale destructions and as sudden creations to account for the extinct organisms revealed by palæontology.

It may, with confidence, be predicted that the day is not far distant when such discordant views of Nature will be unknown in the scientific world; for the progress of discovery proclaims, with ever-increasing force, that the famous axiom *Natura non facit saltum*, is a truth of universal application, and that it is as impossible to sever the life of the present from that of the remotest past as to interpose a barrier between the present and the unknown future.

EXPLANATION OF THE PLATES.

The Plates partially illustrate the most striking cases of Mimicry among South-African Butterflies,—Plate I. consisting chiefly of the species of *Danaidæ* and *Acræidæ* that are the objects of imitation, and Plate II. of the imitating forms belonging to other families.

Plate I.

Fig. 1. *Papilio Meriones*, Felder, ♀, from Madagascar.

The black costal bar in the fore wings indicates how the extreme disparity between the sexes of the very closely allied *Papilio Merope* of the African continent may have originated.

Fig. 2. *Acræa Aganice*, Hewitson, ♂, from D'Urban, Natal.

This species is mimicked by the following, a member of the Family Nymphalidæ, viz.:—

Fig. 4. *Panopea Tarquinia*, Trimen, ♂, from D'Urban, Natal.

Fig. 3. *Danais Echeria*, Stoll, ♂, from Knysna, Cape Colony.

The type-form, prevalent in the Cape Colony, but scarcer to the eastward of it, and rare in Natal.

Fig. 7. *Danais Echeria*, Stoll, var., ♀, from D'Urban, Natal.

This variety prevails in Natal, almost to the exclusion of the type-form.

Fig. 6. *Danais Niavius*, Linn., var., ♂, from D'Urban, Natal.

A Southern form, differing from the Tropical West-African type in the much larger white space of its hind wings.

Plate II.

Fig. 1. *Papilio Merope*, Cramer, ♂, from Knysna, Cape Colony.

Fig. 3. *Papilio Merope*, Cramer, 1st form of ♀, from Knysna, Cape Colony. (*P. Cenea*, Stoll.)

Mimics the type-form of *Danais Echeria*.

Fig. 4. *Papilio Merope*, Cramer, 1st form of ♀, from D'Urban, Natal. (*P. Cenea*, Stoll., var.)

Mimics the Natalian variety of *Danais Echeria*.

Fig. 7. *Diadema mima*, Trimen, n. sp., ♂, from D'Urban, Natal.

Also mimics the prevalent variety of *Danais Echeria* in Natal.

Fig. 2. *Papilio Merope*, Cramer, ♀, variation, from Tsomo River, Kaffraria.

Intermediate between the 1st form of ♀ (*P. Cenea*, Stoll.) and the 2nd form (*P. Hippocoon*, Fab.), and indicative of the yet unstable character of the polymorphic ♀ *Merope*.

Fig. 6. *Papilio Merope*, Cramer, 2nd form of ♀, from Graham's Town, Cape Colony. (*P. Hippocoon*, Fab., var.)

Mimics the Southern form of *Danais Niavius*, and, like the latter, differs from the West-African *Hippocoon* in the much larger white space of its hind wings.

Plate I.

Fig. 5. *Danais Chrysippus*, Linn., ♀, from Cape Town, Cape Colony.

Fig. 8. *Acræa Zetes*, Linn., var., ♂, from Pietermaritzburg, Natal.

A Southern form, *A. Acara* of Hewitson, differing from the Tropical West-African type in the bright, unsuffused colouring of the upper surface of the fore wings.

Fig. 9. *Acræa Zetes*, Linn., var., ♀, from D'Urban, Natal.

The ♀ of the Southern form, *Acara*, Hewitson.

Plate II.

Fig. 5. *Papilio Merope*, Cramer, 4th form of ♀, from Knysna, Cape Colony. (*P. Trophonius*, Westwood.)

Mimics *Danais Chrysippus*, which is abundant at Knysna and throughout the Colony.

Fig. 8. *Panopea Boisduvalii*, E. Doubleday, var., ♂, from D'Urban, Natal.

Mimics the ♂ of the Southern form of *Acræa Zetes*, and, like that insect, differs from the Tropical West-African type in the bright colouring of the fore wings.

Fig. 9. *Panopea Boisduvalii*, E. Doubleday, var., ♀, from D'Urban, Natal.

Mimics the ♀ of the Southern form of *Acræa Zetes*.

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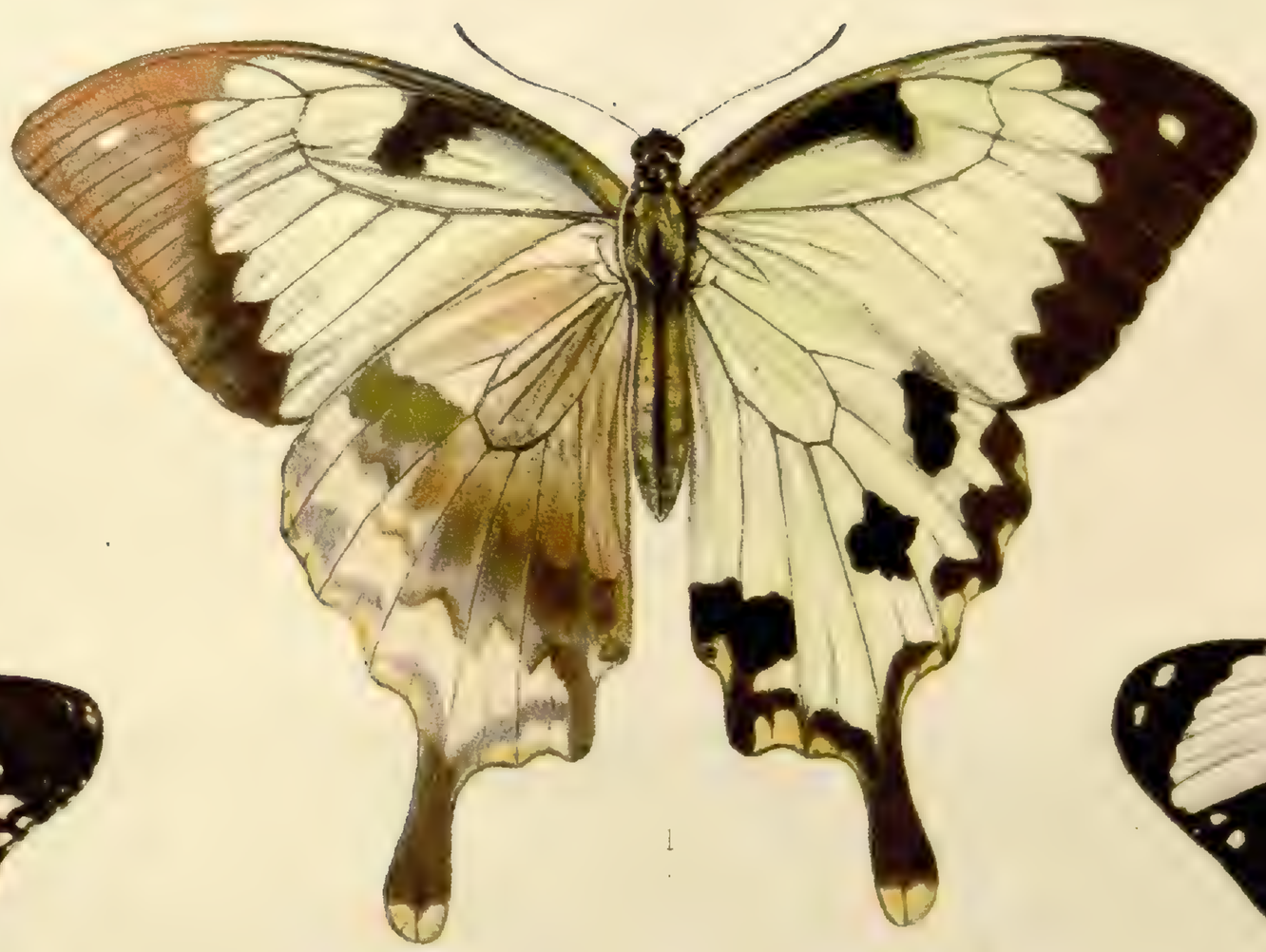

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A G Butler, del. et lith. 1868

Vincent Brooks Day & Son lith.

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A.G. Butler, del. et lith. 1868

Vincent Brooks, Day & Son, Lith.

XI. *The Muscles of the Fore and Hind Limbs in* Dasypus sexcinctus.

By JOHN CHARLES GALTON, *Esq., M.A., Exeter College, Oxford.*

Read June 4th, 1868.

(Plate XLIV.)

PROFESSOR ROLLESTON, F.R.S., my friend and former instructor, having, in the early part of the present year, placed at my disposal, and afforded me every facility for dissecting in the University Museum at Oxford, a specimen of the Six-banded Armadillo (*Dasypus sexcinctus*), I now beg leave to lay before the Society the results of my investigations.

Through the courtesy of W. H. Flower, Esq., F.R.S., Conservator of the Museum of the Royal College of Surgeons, I have been enabled to check and confirm my observations by the examination of a male specimen of a *seven*-banded variety[1] of the species which forms the subject of the present communication. The left side only, however, of this specimen was available for my purpose. The Oxford specimen was also a male, which had been procured from a travelling menagerie, and had been placed in spirit in May 1866. Its weight was 5 lb. 3 oz., and the principal measurements were as follows :—

From tip of snout to extremity of tail $22\frac{1}{2}$ in.; from tip of snout to posterior border of pelvic shield 16 in.; from posterior border of pelvic shield to extremity of tail $6\frac{3}{4}$ in.; from anus to extremity of tail $7\frac{1}{4}$ in.; from tip of snout to posterior border of frontal shield $4\frac{1}{4}$ in.; length of ear nearly $1\frac{1}{2}$ in. The specimen belonging to the College of Surgeons was very slightly smaller.

[1] This specimen must be regarded, apart from a striking superficial resemblance, as belonging to the genus *Dasypus*, since it had five toes on both fore and hind feet, a prominent heel, together with evidence of a plantigrade gait, ears placed far apart, a series of small shields under the eye, and a depressed body. As the specimen was not in the condition of a skeleton, I could not with certainty determine the presence or absence of the intermaxillary tooth, so characteristic of the genus *Dasypus*. The placing of the animal in the digitigrade genus *Tatusia* (the only other alternative) was out of the question. (See Dr. Gray on the "Genera and Species of Entomophagous Edentata," Proc. Zool. Soc. 1865, p. 370 *et seq.*)

In *Dasypus encoubert* (Desm.), *D. 6-cinctus* (Linn.), "the number of moveable bands varies from seven to eight, according to the individual." (Art. ARMADILLO, Cyclopædia of Natural History, vol. i. London, 1856.)

Azara, moreover, mentions a female of this species which had seven bands. (This specimen was of the same size as another female, which possessed but the ordinary number of six bands.) He proceeds to say "J'ai vu d'autres exemples de tout ce que je cite ici ; d'où il résulte que les bandes varient de six à sept, et peut-être les nouveaux-nés n'en ont-ils que cinq." (Essais sur l'Histoire Naturelle de Quadrupèdes de la Province du Paraguay, par Don Felix D'Azara—traduits sur le Manuscrit inédit de l'Auteur, par Moreau Saint-Méry. Paris, 1801. Vol. ii. pp. 148–9.)

Since the first part of this note was written, I have seen, among the collection of stuffed specimens of Bruta preserved in the British Museum, one presenting all the external characteristics of, and, moreover, labelled as, *Dasypus sexcinctus*, which had seven, well-marked, dorsal bands.

My observations have been confined to the muscles connected with the fore and hind limbs only, since these are of the most importance for the determination of general and serial homologies.

Recourse has frequently been had to the beautiful plates, illustrating the myology of the Armadillo, contained in Cuvier's splendid work upon Comparative Anatomy[1]; but I had better here, since I concur in the conclusion, borrow the language of a countryman of the great anatomist, in order to clear myself completely from suspicion of being biased by insular prejudices: "Mais les dessins qu'il en donne sont assez imparfaits, et n'ont pu nous être que d'un faible secours"[2].

Rapp, in his excellent monograph on the Edentata[3], has described the muscles of the limbs in *Myrmecophaga tamandua* only; but I shall nevertheless have, from time to time, occasion to refer to his descriptions, for the purpose of comparison.

Upper Extremity.—Great extent of motion seems denied to this member; for, upon reflecting the skin merely, the forearm will be found flexed upon the arm, and this latter again closely applied to the side and bound down by fascia, leaving perfectly free and unembarrassed movement to the carpal joint only. The forearm, moreover, does not appear to be capable of being extended from the upper arm to a greater degree than a right angle. This limitation of motion seems to be in a great measure due to the high attachment along the humerus of the *extensor carpi radialis*. With regard to the rotation of the forearm, the extent of supination is small; and this is probably owing to the hindrance occasioned by the attachment of the *pronator teres*—the utmost limit attainable being a position exactly halfway between that of extreme pronation and supination, the palm of the hand facing inwards towards the body. The impingement of the olecranon against the external condyle of the humerus however, appears, to be the greatest obstacle to complete supination.

The complete absence, too, of a *pronator quadratus*[4] in this animal must be associated, in the way either of cause or of effect, with the limitation of rotation of the forearm, as also the very feeble condition of the *supinator brevis*, which is rendered the more striking by the full development of surrounding muscles, and notably of its antagonist, the *pronator teres*,—a condition to be regarded by some as the expression of a predetermined plan[5], by others as the promise of future increase[6], and by others, again, as the sole heirloom remaining to posterity out of the substance of a neglected property[7].

[1] Cuvier, Laurillard et Mercier, 'Anatomie Comparée, recueil de planches.' Fol. Paris, 1855.

[2] Georges Pouchet, 'Mémoires sur le Grand Fourmilier.' I^e^ livraison. Paris, 1867.

[3] Anatomische Untersuchungen über die Edentaten, von Wilhelm von Rapp. Tübingen, 1852.

[4] In compensation for ("dagegen") this, however, according to Meckel, the *pronator teres* is very broad, and has an extensive insertion. (System der vergleichenden Anatomie. Halle, 1828. Dritter Theil, p. 530.)

[5] "As the study of comparative osteology leads us to the conclusion that there is a typical skeleton, of which all vertebrate skeletons are modifications, so the study of myology teaches us that there is a typical vertebrate *myozoon*, of which the individual vertebrate muscular systems are modifications." (Dr. A. Macalister, "Contributions towards the formation of a correct system of Muscular Homologies." Ann. & Mag. of Nat. Hist. 4th ser. vol. i. p. 314.)

[6] See Agassiz on "Prophetic Types." (Essay on Classification. London, 1859: p. 175.)

[7] See Darwin, 'Origin of Species,' 3rd ed. London, 1861, p. 151 *et seq.*, also p. 487; 'Variation of Animals and Plants under Domestication,' London, 1868, vol. ii. p. 317. Paget, 'Lectures on Surgical Pathology,' edited by Dr.

Rhomboidei.—These muscles appear to have been fused together into one, and are, moreover, scarcely to be differentiated from the upper portion at origin of the *latissimus dorsi*. They take origin from the spines of the six upper dorsal vertebræ—that part which arises from the two uppermost being fleshy from the beginning, while the rest of the muscle takes origin from an aponeurosis continuous with that from which the *latissimus dorsi* arises. They are inserted into the whole length of the base of the scapula.

This fusion of the *rhomboidei* into one muscle occurs, according to Church[1], in animals as high in the scale as the Orang and Chimpanzee. Meckel[2], however, describes these muscles as distinct in the Armadillo, the anterior passing to the occiput, the posterior being fused with the *latissimus dorsi*.

Henle states[3] that Albinus has seen the *rhomboideus major* fused with the upper edge of the *latissimus dorsi* in Man.

Occipito-scapular.—This muscle, which is slightly, but not very clearly, indicated by Cuvier[4] as the "rhomboïde de la tête," is enormously developed. It arises from the whole extent of the occipital crest, being covered by that portion of the *trapezius* which takes origin here, and is inserted, partly into the fascia covering the *supraspinatus*, partly into the upper angle of the base of the scapula. Each muscle meets with its fellow in the middle line.

This muscle, I think, answers to one which Mr. Wood has described[5] under the same title as having occurred as an "abnormality" in Man. The same author found a like muscle in the Rabbit, which resembles that described by Krause, in his monograph upon the same animal[6], as the "levator scapulæ minor," except that the latter is inserted as low down as the inferior angle of the scapula. A similar muscle has been found by Mr. Mivart and Dr. Murie in the Hare and Guinea-pig, as well as in the Rabbit, and is termed by them "rhomboideus capitis"[7].

Levator scapulæ.—This appears to be a muscle distinct from the preceding. It is very fleshy, and takes origin from certain of the lower cervical vertebræ; it is inserted into the inner face of the superior angle of the scapula, and also along the posterior half of the superior costa of the bone. Cuvier notices this latter mode of insertion[8], and remarks that in mammals the muscle is rarely distinct from the *serratus magnus*, of which it is, properly speaking, but an anterior offset. Meckel[9] describes this muscle as entirely distinct from the *serratus magnus*, of which, however, it appears at first sight to be a factor.

Turner, London, 1863, p. 91. Herbert Spencer, 'Principles of Biology,' vol. i. p. 387, London, 1864; vol. ii. p. 359, London, 1867.

[1] Natural History Review, no. iv. Oct. 1861, p. 511.

[2] Syst. der vergleich. Anat. (Halle, 1828), dritt. Theil, p. 483.

[3] Muskellehre, p. 27: Braunschweig, 1858.

[4] *Op. cit.* pl. 259. fig. 2.

[5] Proc. Roy. Soc. May, 1867, p. 520.

[6] Anatomie des Kaninchens (Leipzig, 1865), p. 104.

[7] "Anatomy of the Crested Agouti," Proc. Zool. Soc. June 1866, p. 393.

[8] Leçons d'Anatomie Comparée, 2me éd. Paris, 1835, tom. 1. p. 370.

[9] *Op. cit.* p. 478.

The *serratus magnus* appeared to be in two distinct divisions, with which the preceding muscle seemed at first sight to be incorporated as a third factor. Both are thin and fan-shaped, and both are inserted into the sabre-like inferior angle of the scapula, the upper overlapping the lower at insertion. The latter factor arose from the third to the sixth ribs inclusive, posterior to their cartilages, while the origin of the former was confined to the first and second ribs.

Though not strictly under the same category as the muscles of the shoulder, the *omo-hyoid* may, I think, be noticed here, since one of its normal attachments is at the superior costa of the scapula. I did not succeed in finding this muscle in the Armadillo, and therefore conclude that it is absent. Both Meckel and Cuvier are silent with respect to its presence or absence in this animal; but both say positively that in the Sloths it is entirely absent—"manque tout-à-fait."

The latter author describes this muscle in the Anteater[1] (species not given); but Professor Owen makes no mention of it in his description of the muscles of the tongue of *Myrmecophaga jubata*[2].

Trapezius.—This muscle is well seen on reflecting forward over the head the scapular shield. Its fibres are coarse, and it appears to be made up of two distinct factors.

The upper, corresponding to the "portion occipitale" of Cuvier[3], arose from the cellular tissue in the middle line of the cervical region, for about five inches below the occiput, and was inserted along the principal spine of the scapula as far as the end of the acromion—the whole extent of its acromially inserted portion being overlapped by an offset from the upper part of this factor of the muscle, which passed under the terminal portion of the *acromio-basilar* to become finally lost in the strong fascia which invests the shoulder and arm.

The lower, which answers to the portion termed "dorsale" by Cuvier, took origin from the neural spines of the third and succeeding dorsal vertebræ, and from a strong fibrous aponeurosis stretching between the spines and metapophyses of the lumbar vertebræ. It then passed upwards and outwards to be inserted by a broad triangular tendon along the posterior half of the principal spine of the scapula, being slightly overlapped here by the occipital portion of the muscle. In the specimen from which I took these notes, the fibres of the first-described portion of the muscle were pale in colour, while those of the dorsal factor were of a deep rich reddish-brown tint. This contrast may only be due to a difference in the stages of decomposition undergone by the two divisions of the muscle; but it, nevertheless, seems to point to some slight want of completeness in the harmony of their relationship.

No fibres of this muscle are inserted into the clavicle. According to Meckel[4] the *trapezius* has an insertion into the posterior half of this bone in the Anteater, and into its rudiment in the Aï.

[1] *Op. cit.* tome iv. 1e partie, p. 490.
[2] "On the Anatomy of the Great Anteater," Trans. Zool. Soc. July 1854.
[3] Anat. Comp. pl. 259. fig. 2.
[4] *Op. cit.* p. 468.

The clavicular portion of the muscle is, moreover, wanting, according to Pfeiffer[1], in many Apes and Lemurs, in Bats, in the Hedgehog, Hystrix, and Arctomys.

The *acromio-basilar* is very distinct, and is fairly developed. It takes origin from the lateral ridge of the supraoccipital bone, and passes thence obliquely downwards and outwards to be inserted tendinously into the strong downwardly directed tubercle at the base of the acromion—"metacromial process" of Parker[2].

Not far from its termination it passes over that part of the occipital division of the *trapezius* which is detached to join the fascia of the arm.

Cuvier evidently considered this muscle to be a factor of the *trapezius*, seeing that it is lettered by him in his plates[3] as its "portion cervicale."

According to Meckel[4] the *acromio-basilar*, to which he has given no distinct designation, is to be regarded, either as a portion of the *trapezius*, or as a muscle *sui generis*. The first of these views, he holds, receives support from the arrangement of the muscle in the Otter, in which animal it springs from the internal face of the *trapezius*—this latter being consequently differentiable into an external and internal layer. He does not agree with Cuvier that it is a *levator scapulæ* carried far forward, because, 1, of its coexistence with that muscle in all animals where it is present; 2, of its superficial position in the Makis and certain Apes.

Church[5] found a representative of this muscle in the Orang; and Wagner, according to Henle[6], discovered in the human subject an accessory portion of the *trapezius* which passed to the acromion from the mastoid process.

Levator claviculæ.—A fairly developed muscle, which takes origin from the strong fibrous aponeurosis covering the occipito-parietal region of the skull, immediately to the outside of the origin of the preceding muscle. It then runs along close to the outer edge of the *cleido-mastoid*, and parallel with it, and is inserted into the clavicle, just external to the terminal portion of the muscle.

Cuvier gives a very fair representation of it on the right side of his figure (pl. 260, Anat. Comp.), but attaches to it neither letter nor sign.

Cleido-mastoid.—Is a comparatively broad and flat muscle, arising from the mastoidal portion of the temporal bone, posterior to, and overlapped by, the origin of the *sterno-mastoid*. It passes down, slightly and gradually diverging from this muscle, to be inserted into the sternal third of the clavicle, a slight interval being left between the inner limit of its insertion and the sterno-clavicular articulation.

Sterno-mastoid.—Arises from the mastoid process of the temporal bone, in close contiguity to, but covering, the preceding muscles at origin. Though running in company with the above at first, it gradually parts company, and is finally inserted along the upper edge of the manubrium. Certain fibres, however, which are derived from the anterior free edge of the muscle, are continued over the *pectoralis major*, to meet a similar prolongation from the *sterno-mastoid* of the opposite side, and to be finally

[1] Zur vergleichenden Anatomie der Schultergerüstes und Schultermuskeln. Hermann Pfeiffer. Giessen, 1854: p. 13.

[2] *Vide* A Monograph on the Structure and Development of the Shoulder-girdle and Sternum in the Vertebrata. Ray Soc. 1868: p. 203.

[3] Anat. Comp. pl. 259. fig. 2.

[4] *Op. cit.* p. 481.

[5] *Loc. cit.* p. 512.

[6] *Loc. cit.* p. 24.

inserted, in company with the above prolongation, along the whole length of the manubrium in the middle line. This last-described element of the muscle, by overlapping that portion of the *pectoralis* which takes origin from the manubrium, and those fibres of the *sterno-mastoid* which terminate along the upper edge of this sternal factor, aids in the formation of a kind of muscular sac, having the concavity looking outwards.

Meckel describes the *sterno-* as distinct from *cleido-mastoid* in *Dasypus*; and states that both these factors of the compound muscle, especially the first, are of great thickness. The *sterno-mastoid*, according to him, is attached along the whole of the first third of the sternum. This muscle is also double in the Anteater; but the *sterno-mastoid* in the Aï has this peculiarity, that at its upper part it splits into two pointed heads (Zipfel), between which lies the styliform process[1].

The *sterno-cleido-mastoid* is clearly represented by Cuvier in one of his plates[2].

This muscle, in *Dasypus sexcinctus*, has no relation whatever, either of contiguity or continuity, with the terminal portion of the *rectus abdominis*[3].

Subclavius.—A very stout fleshy muscle. It arises from the irregularly oval and roughish depression seen at the expanded anterior termination of the first rib, also from its superior edge, for a short distance. It then passes obliquely outwards over the axillary vessels and nerves, and, dipping beneath the clavicular portion of the *deltoid*, with which it makes exactly a right angle at the point of crossing, passes to its insertion. It is inserted by a flat tendon along the whole extent of the upper ridge of the long acromion process of the scapula, and becomes, moreover, continuous with the strong fascia which covers the head of the humerus, and which is also lost over the *supraspinatus*. The strong coraco-clavicular ligament passes across through the substance of the muscle, close to the insertion of the latter, splitting it into two unequal portions, the smaller and anterior of which dips under the ligament to join its tendon, while the largest portion, comprising about two-thirds of the muscle in this part of its course, passes over the ligament.

Meckel makes no mention of the presence or absence of this muscle in *Dasypus*.

The smaller factor of a muscle in *Dasyprocta cristata*, termed by Mr. Mivart and Dr. Murie, in their paper on this Rodent[4], *sterno-scapular*, has great resemblance to the muscle in *Dasypus* which I have called *subclavius*. This factor of the *sterno-scapular*, which may be the *subclavius*, as the above authors, following Meckel[5], suggest, arose "from the outer side of the base of the manubrium and from the cartilage of the first rib," and, at about an inch beyond the distal end of the clavicle, united with the larger portion of the muscle, with which it was inserted "close to the anterior vertebral angle of the scapula. Some fibres pass over the supraspinatus, and are attached by fascia to the spine of the scapula."

The *subclavius* was absent in a specimen of *Myrmecophaga tamandua* (non-claviculate)

[1] *Op. cit.* p. 422.

[2] *Op. cit.* pl. 260.

[3] For the bearings of this point see Prof. Turner's paper "On the Musculus Sternalis," Journ. of Anat. and Phys. vol. i. p. 250, 1st series. Cambridge 1867.

[4] "On the Anatomy of the Crested Agouti," Proc. Zool. Soc. June 1866, p. 398.

[5] *Op. cit.* p. 444.

which I examined at the University Museum at Oxford. Rapp, moreover, in his monograph on this species of Anteater, makes no mention of this muscle; nor does Cuvier figure it in his plates of the myology of this animal.

The *subclavius* is not mentioned in M. Pouchet's monograph upon the (also non-claviculate) *M. jubata*[1].

With regard to the claviculate *M. didactyla*, Meckel, in his monograph on this species[2], makes no mention of the muscle in question; nor does Cuvier represent it in his drawings of this animal's anatomy.

In a specimen of the Two-toed Sloth (*Cholœpus didactylus*) which I examined at Oxford, I found the *subclavius* in the form of a long and slender fusiform slip, which passed from the first rib to be inserted into the scapular third of the clavicle, and into the acromial process of the scapula.

Cuvier, in his plates illustrating the myology of *Bradypus tridactylus*, gives a figure of a muscle which has a slight resemblance to the *subclavius*, but attaches to it the symbol of the *pectoralis minor*[3].

In the Wombat (*Phascolomys wombata*) "the subclavius arose by two heads, one a very delicate one, arising from the lower ribs and passing vertically upwards to end in a fine tendon; the other, a thick fleshy one, arose from the first rib and was inserted into the outer end of the clavicle, and, by means of fascia covering the supra-spinatus, into the whole length of the spine of the scapula"[4].

In the Porcupine this muscle is of great length, strap-shaped, of nearly uniform breadth. It arises from the costal portion of the first rib, has a slight attachment to the scapular extremity of the clavicle, and is finally inserted, by means of a thin tendon, along the spine of the scapula, becoming continuous, moreover, with fascia which covers the *supraspinatus* and which is also attached to the anterior edge of the scapular factor of the *deltoid*. Upon reaching the shoulder the muscle broadens, and continues of this increased breadth until it reaches its insertion over the *supraspinatus*.

The termination of this muscle in the above rodent is very fairly represented by Cuvier in one of his plates[5].

In Gratiolet's monograph upon the Hippopotamus, there is a muscle described under the name "scapulo-sternal," which arises from an aponeurosis covering the muscles of the supraspinous fossa of the scapula, and attached to the border of the coracoid and acromion, and terminates at the manubrium of the sternum. The following footnote is appended to the description of this muscle:—"Ce muscle dont l'insertion s'étend sur le cartilage de la première côte, représente probablement le *sous-clavier*"[6].

[1] Mémoires sur le Grand Fourmilier, par Georges Pouchet. 1e livraison. Paris, 1867.

[2] J. F. Meckel, "Anatomie des zweizehigen Ameisenfresser," Archiv für die Physiologie, fünfter Band (Halle und Berlin, 1819).

[3] *Op. cit.* pls. 252, 253.

[4] The above extract is taken, by kind permission of Prof. Rolleston, from one of the volumes of the 'Student's Note Book,' which is kept in the biological department of the University Museum at Oxford, for the purpose of recording anatomical and physiological observations of importance.

[5] *Op. cit.* pl. 229. fig. 2.

[6] Gratiolet, 'Recherches sur l'Anatomie de l'Hippopotame,' publiées par les soins du Dr. Edmond Alix. Paris. 1867: p. 256.

Deltoid.—This muscle appears to consist of three factors, which are as follow :—

1. *Clavicular*, a flat muscular slip, arising from the acromial extremity of the clavicle. It has a rhomboidal (but almost approaching a triangular) shape, and narrows in breadth towards its insertion into a smooth oval facet situated on the outer aspect of the deltoid trochanter of the humerus. This portion of the muscle, before its insertion, fuses with the rounded superior portion of the *pectoralis major*, at the termination of this latter, and with the factor of the *deltoid*, next to be described.

2. *Acromial*, a stout, fleshy, subcylindrical muscle, arising, slightly tendinous at origin, from the posterior half of the long acromial offset of the scapula, immediately in front of the "metacromial process" of Parker. It passes obliquely forward, and, after fusing with the clavicular factor of the *deltoid*, shares with it its insertion.

3. *Scapular.* This, the largest factor of the muscle, is triangular in shape, and arises from the whole length of the outer side of the principal (superior) spine of the scapula, from its termination at the base of the bone to its origin at the spring of the acromion; being overlapped for the last inch and a half of its origin by the dorsal portion of the *trapezius.* It passes obliquely forwards, narrowing very rapidly from its broad base, to be inserted into the ridge bounding the facet which gave insertion to the two former factors of the muscle, but becomes, moreover, continuous with the fascia of the arm, to which the occipital portion of the *trapezius*, as already described, furnishes a contribution. This factor of the *deltoid* overlaps that portion of the acromion which affords origin to the factor which I have termed *acromial.*

Supraspinatus.—This muscle has no peculiarities worthy of record. It arises from the whole of the supraspinous fossa of the scapula, and has a very broad fleshy insertion into the upper edge of the external tuberosity of the humerus.

Infraspinatus.—In the small infraspinous, or rather *interspinous*, fossa which lies between the greater and lesser spines of the scapula, arises the above muscle, which is inserted into the outer tuberosity of the humerus, at a point a little above that of the termination of the muscle next to be described.

Teres minor.—A muscle of no great breadth, arising from the whole length of the lesser (inferior) spine of the scapula, above the origin of the "long" head of the *triceps.* Passing forwards, parallel with the ridge from which it takes origin, it is inserted into a spinous projection below the outer tuberosity of the humerus, developed upon a ridge which runs upwards from the outer edge of the deltoid trochanter. Overlapping the origin of the "long" head of the triceps, and, close to its insertion, the origin of the external factor of the same muscle, it is overlapped in turn by the most posterior (*scapular*) portion of the *deltoid.*

Subscapularis.—This muscle takes its ordinary origin from the inner aspect of the scapula, and is inserted by a broad tendon into the inner tuberosity of the humerus.

Teres major.—Arises from the posterior triangular space lying between the lesser (or inferior) spine of the scapula and the inferior angle of the bone[1]. At their origin,

[1] "L'angle postérieur des *tatous* est remarquable par sa courbure et sa saillie aiguë." (Cuvier's Leçons, 2nd ed. *loc. cit.* p. 352.)

its fibres fuse with that most posterior factor of the *triceps* which joins the *latissimus dorsi* as this latter gives off its *dorso-epitrochlear* contingent to the elbow, also with that portion of the *latissimus dorsi* which passes up to the usual insertion at the shaft of the humerus.

It is inserted tendinously into the humerus, immediately below the latter muscle.

Latissimus dorsi.—This muscle arises from the "metapophyses" (Owen) of the lumbar vertebræ, and from the lumbar aponeurosis, between those posterior fibres of the dorsal portion of the *trapezius* which terminate in this aponeurosis and the anterior fibres of origin of the *gluteus maximus*—also from fascia which lies beneath the factor of the *trapezius* mentioned above, and which covers one of the longitudinal dorsal muscles. Its upper fibres of origin are scarcely, if at all, to be differentiated from the lowermost portion of the *rhomboidei* muscles, or muscle.

Certain fibres, moreover, take origin from the bony elements of all the true ribs from the fifth downward, those which arise from the fifth to the ninth inclusive passing straight upwards towards the tendon of insertion of the muscle.

The whole of the outer aspect of the thorax is, in short, completely covered by the fibres of this muscle.

Those costal elements which derive their origin from the ribs posterior to the ninth, and that portion of the muscle which arises from the dorsal region of the trunk, pass together obliquely upwards and onwards, and contribute mainly to the formation of the well-developed *dorso-epitrochlien*. This cubital offset from the *latissimus dorsi*, after dropping a few fibres in the fascia covering the elbow, is continued over this process, and proceeds for some distance along the inner aspect of the forearm, to be finally lost in the fascia of this region.

Those costal fibres mentioned above as taking origin from the ribs between the fifth and ninth inclusive, after fusing with the proximal portion of the *dorso-epitrochlear* branch, and also very slightly with the *teres major*, at its origin, pass gradually into the terminal tendon of the *latissimus dorsi*—which, after passing under the axillary vessels and nerves, is inserted into the shaft of the humerus, on its inner aspect, a little below, and to the outer side of, the insertion of the "short" variety of the *coraco-brachialis*, and above that of the *teres major*.

Certain muscular fibres take origin from the ribs between the fifth and ninth inclusive, anterior, but close, to those costal elements of the *latissimus dorsi* already described as arising from the same ribs, and pass straight upward to that portion of the broad terminal tendon of the *pectoralis major* which has the highest insertion into the humerus.

Cuvier's representations of this muscle are clear, and agree very fairly with my observations[1]. The costal slip, last described, is figured very distinctly as passing, outside the *external* oblique, upwards, and slightly outwards, over the axilla, over the *coraco-brachialis* and *biceps*, to be inserted into the humerus above, but in company with, the upper part of the tendon of insertion of the *pectoralis major*, of which muscle, moreover, if his appended symbols do not belie his meaning, Cuvier apparently considered it to be a factor.

[1] Anat. Comp. pl. 259. fig. 2, and pl. 260.

Now Meckel, in his description of the *pectoralis major* in the "Tatu," says expressly that this muscle has no origin from the ribs[1]; besides this, the costal slip above mentioned bears very great resemblance to one of those offsets from the *latissimus dorsi*, (the "Achselbogen" of German anatomists) which are by no means uncommon in the human subject as slips which pass from this muscle over the axillary vessels and nerves to join the tendon of the *pectoralis major* at its insertion. Mr. John Wood has described several such in papers read before the Royal Society, and has, moreover, suggested[2] that these are "imperfect developments of the so-called *dorso-epitrochlear* muscle of the lower animals." The coexistence, however, with this muscle of the costal slip which I have described above, could hardly be cited in support of such a conclusion.

Cuvier's figure of the prolongation of the *dorso-épitrochlien* into the forearm, and of its fascial termination in this region, is most distinct[3].

Meckel describes the *latissimus dorsi* in *Dasypus* as coming from the vertebral column, from the second thoracic vertebra, and from the third to the last rib. It then splits itself into two fascicles, one for the humerus, the other for the whole anterior half of the ulna and the antebrachial aponeurosis, which last is very broad[4].

I have examined the *dorso-épitrochlien* in the Tamandua, "Unau" (or Two-toed Sloth), and Wombat. In the former animal, as in *Dasypus*, this muscle became continuous with the fascia of the forearm. Rapp describes it, in the same species, as taking origin, in company with the *teres major*, from the scapula, and being inserted at the olecranon. He proceeds to state that "ein Theil seiner Sehne geht in die *Fascia* des Vorderarms über, die er spannen kann"[5]. The same muscle is represented by Cuvier, in his figures of the Two-toed Anteater, as being continued a long distance into the forearm[6].

In *Cholœpus didactylus* this muscle consists of a thin somewhat cylindrical slip, being rolled on itself, and is inserted principally into the anterior ridge bounding the supracondyloid foramen, and partly into the humerus, above the foramen, a little below the insertion of the *coraco-brachialis*, between which terminal portions of the muscle the median and ulnar vessels and nerves pass. This muscle has no prolongation into the forearm. A similar supracondyloid termination is figured in one of Cuvier's plates of the myology of *Bradypus tridactylus*[7].

In the Wombat the *dorso-épitrochlien* terminates at the olecranon, previously blending with the tendon of insertion of the most posterior division of the *triceps*. A slip is, moreover, sent from the most anterior portion of the *latissimus dorsi*, over the axillary vessels and nerves, to join the highest part of the tendon of the *pectoralis major*. This may belong, however, to the *panniculus carnosus*; but this latter is so closely blent with the anterior edge of the *latissimus dorsi*, that it is difficult to determine satisfactorily the nature of the muscle in question.

Henle figures, in his work upon human anatomy, a tendinous offset passing from the beginning of the tendon of the *latissimus dorsi* to that of the "long" head of the *triceps*

[1] "Von den Rippen kommt er dagegen nicht." Vergleich. Anat. *loc. cit.* p. 508.
[2] Proc. Royal Soc. June 1866, p. 231.
[3] *Op. cit.* pl. 260.
[4] *Op. cit.* p. 502.
[5] *Op. cit.* p. 48.
[6] *Op. cit.* pl. 258. fig. 1.
[7] *Op. cit.* pl. 253.

(*m. anconeus longus*), which is probably a representative of the *dorso-épitrochlien* of lower animals[1].

Pectoralis major.—This muscle takes origin from the whole length of the sternum, manubrium included, in the middle line, from the ensiform process, and from the upper half of the abdominal aponeurosis which forms the anterior wall of the sheath of the *rectus*.

There is no clavicular origin.

A few delicate riband-like fibres appear to be derived from the outer side of the muscle, which run down in an almost straight direction on either side along the abdomen, to be eventually lost in the fascia of the inguinal region. These may, however, more properly belong to some deep-lying element of the *panniculus carnosus*.

The *external oblique* joins the aponeurosis at the point where the lowest fibres of the *pectoralis* terminate.

The *pectoralis* is thickest in the region of the manubrium sterni, and gradually thins as it nears the lower region of the thorax and the abdominal aponeurosis.

The muscle is inserted into the humerus by a broad, thin tendon, along the sharp inner edge and hamular projection of the deltoid trochanter, being, as in man, folded upon itself; so that its thin lower margin has the highest attachment, while the thick, rounded, upper border is inserted much lower down, so as to fuse with the *deltoid* muscle at its termination. The tendon, at its highest part, becomes continuous with a shining aponeurosis which covers the head of the humerus.

Meckel, in his description of this muscle in the "Tatu,"[2] attaches some importance to the fascicle which arises from the ensiform process—"den er kraftvoll emporhebt, was, wenn das Thier zusammengekugelt ist, für das Athmen wichtig ist." This is applicable, however, to *Tolypeutes* alone, no other Armadillo being known to possess, or rather to exercise, the faculty of rolling itself together into a ball[3].

In a representation of each of the two genera of Monotremata, namely, a specimen of *Ornithorhynchus paradoxus*, and of *Echidna setosa*[4], which I was enabled through the kindness of Prof. Rolleston to examine at Oxford, I have found the downward prolongation of the muscle into the abdominal aponeurosis. In both cases, however, this portion was naturally differentiated from the pectoral factor of the muscle—so much so

[1] Muskellehre, p. 182, and fig. 88.

[2] *Op. cit.* p. 508.

[3] "Die Schuppenthiere (the *Manis*) und *Dasypus tricinctus* können sich zusammenrollen, wie ein Igel."—*Rapp. op. cit.* p. 64.

Darwin says of this species (under the name of "*Apar*"), "It has the power of rolling itself into a perfect sphere, like one kind of English Woodlouse."—*The Voyage of a Naturalist round the World*, p. 96, 2nd ed. London. 1845.

"One species only" according to the 'Cyclopædia of Natural History,' *loc. cit.*, article "Armadillo," "has the faculty of rolling itself up into a round ball like a hedgehog." This is, further on, stated to be the Three-banded Armadillo. Azara, *loc. cit.* p. 197, says of this, his eighth species, "Beaucoup de personnes l'appellent *bolita* (petite boule) parce que c'est l'unique Tatou, qui lorsqu'il craint, ou lors qu'on veut le prendre, cache sa tête, sa queue et ses quatres pieds, formant de tout son corps, une boule," &c.

He says further on (p. 199), "Il y a trois bandes mobiles."

[4] For descriptions of the above species (?) see Gould's 'Mammals of Australia,' vol. i.; Waterhouse's 'Nat. Hist. of the Mammalia,' vol. i. p. 47; List of Mammalia in British Museum (Lond. 1843), p. 192.

that Prof. Rolleston proposed for it the distinctive term "pyramidal" portion—a name derived from the muscle subjacent to the aponeurosis with which it was continuous.

Reptiles and Batrachians, as well as Mammals, are able to furnish instances of the modification of the *pectoralis major* mentioned above.

I have found a like downward continuation of the *pectoralis* into the aponeurosis covering the *rectus abdominis* in a young Crocodile; and Ecker, in his Monograph upon the Frog, describes and figures under the name "portio abdominalis" (*abdomino-huméral*, Dugès) a similar prolongation of this muscle, "welche mit der Aponeurose des *M. obliquus abdominis externus* in Verbindung steht"[1].

Pectoralis minor.—I did not succeed in finding any representative of this muscle.

According to Meckel, this muscle is absent in *Myrmecophaga* and *Bradypus* among Edentata, among Marsupials, in the Opossum and Kangaroo, and in most Rodents. Further on, he describes in *Dasypus* a muscle which passes from the first rib, under the *pectoralis major*, to the humerus, where it finds insertion above this latter muscle. A similar muscle is present in *Arctomys*, but arises from the middle region of the sternum. Meckel suggests that this muscle may not be the *pectoralis minor* after all, but a differentiated portion of the great *pectoral*[2]. May it not be, however, the *subclavius*?

Coraco-brachialis.—This muscle arises from the coracoid process of the scapula by a strong and fair-sized tendon. About the distance of half an inch from its origin, where muscular fibres begin to blend with the tendon, a delicate slip is given off from the inner side of the muscle, which winds round beneath the inner tuberosity of the humerus, to be inserted into the neck of the bone, or capsule of the joint, at a point between the articular head and the above tuberosity. This muscular offset evidently represents the "short" variety, as it has been termed by Mr. John Wood. At the distance of an inch after giving off the above muscular slip, the *coraco-brachialis* joins the *biceps*, and is partly continued with this muscle into the forearm, partly is prolonged, as a considerable slip, to the ridge which runs upward from the inner condyle to form the anterior boundary of the supracondyloid foramen. This, the "long" variety of the muscle, is the only form recorded by Mr. Wood[3] as being present in the Armadillo, of which, however, the species examined is not mentioned. The "short" variety of the muscle was present, in a condition of equal development, on both sides in the Oxford specimen of *Dasypus sexcinctus* which I examined, and on the left side (the only side available for dissection) of the specimen belonging to the Royal College of Surgeons.

I have omitted to state that a few fibres of the terminal portion of the "long" variety were inserted into the posterior boundary of the condyloid foramen, and at a higher level than those which terminate at the anterior ridge, and are separated, moreover, from these latter by the median vessels and nerve.

[1] Die Anatomie des Frosches. Von Dr. Alexander Ecker (Braunschweig, 1864). 1ste Abtheil. p. 95, fig. 73.

[2] *Op. cit.* pp. 490–91.

[3] "In the Armadillo it (the *coraco-brachialis*) is also single, and is implanted upon the supracondyloid arch or foramen just above the inner condyle, thus presenting the long variety of the muscle."—On Human Muscular Variations and their Relation to Comparative Anatomy. By John Wood, F.R.C.S.—Journ. of Anat. and Phys. 1st ser. (Cambridge, 1867) vol. i. p. 51.

The *coraco-brachialis* in *Cholœpus didactylus* is a thin, cord-like muscle of uniform size, and, like its homologue in *Bradypus*, as described by Mr. Wood in the paper to which I have already made reference, represents the ordinary or *middle* variety only of the muscle.

Among other animals in which, through the kindness of Prof. Rolleston, I have been enabled to examine and make sketches of this muscle are *Macropus tamandua*, *M. ruficollis* (var. *Bennetti*[1]), *Phascolomys wombata*, and a specimen of *Hystrix* (*cristata*, I think).

In the *Tamandua* this muscle arises from that portion of the superior edge of the scapula which is anterior to the omohyoidean notch (or foramen), and which may represent a rudimentary coracoid, in company with the *biceps*. It then passes over the inner tuberosity, completely covered by the fibres of insertion of the *subscapularis*. Upon a level with the superior edge of the *latissimus dorsi* the muscle divides, the inner portion passing down straight, but gradually widening to its insertion above the inner condyle, while the outer branch joins the *biceps* at about the level of the condyloid foramen. Upon reflecting those fibres of the *subscapularis* which cover the *coraco-brachialis* as it passes over the inner tuberosity, there may be seen a delicate band of muscular fibres, which arises in the acute angle made by the tendons of origin of the *biceps* and the preceding muscle and appears to take rise from the common aponeurosis of origin of these two muscles, and which is inserted into the outer portion of the inner tuberosity of the humerus[2]. Its fibres are as nearly parallel to those of the *subscapularis* as those of any broad muscle can be which converge towards their termination. Is this slip to be regarded as an outlying element of the *subscapularis*, or as the representation of the *short* variety of the *coraco-brachialis* which has dropped short of its ordinary insertion?

In *Macropus ruficollis* this muscle appears to be represented by the "short" variety of Wood only, but presented some note-worthy peculiarities, a description of which I subjoin in a footnote[3]. This variety only is, moreover, present in the Wombat, being

[1] Waterhouse, *op. cit.* p. 130.

[2] M. Pouchet, in his Monograph upon *Myrmecophaga jubata*, already cited, figures (pl. ii. fig. 4) and describes (p. 7) an arrangement in this species, of the fibres of the *subscapularis*, precisely similar to that just described as existing in the Tamandua. M. Pouchet says, *loc. cit.*, of the termination of the *subscapularis*, "cette insertion se fait par un puissant tendon perforé, ou plutôt divisé en deux parties, entre lesquelles glisse le tendon de la courte portion du biceps."

[3] This description is taken, with Prof. Rolleston's permission, from one of the volumes of the afore-mentioned 'Student's Note-Book:' "From the coracoid in this animal a muscle arises, in close relation to, but not connected with, the upper fibres of the *subscapularis*; it receives an accessory head from the tendon of the *biceps*, and is itself divisible into two fascicles—of which the smaller and deeper in position is inserted immediately below the insertion of the *subscapularis*, and at right angles to it, while the larger occupies the space left vacant on the humerus between the insertion of the *subscapularis* and that of the conjoined *teres major* and *latissimus dorsi*."

From the same source I borrow the following description of the *coraco-brachialis* in *Macropus giganteus*:—"A thin muscular slip arises from the superior border of the scapula near the origin of the *omo-hyoid*. It is separable for an inch and a half from the *subscapularis*, over the tendon of which it passes; it is attached for half an inch to the tendon of the biceps, where it glides over the inner tuberosity of the humerus. From this point it passes downwards to be inserted on the inner side of the humerus, above, but in close proximity to, the insertion of the teres major, overlying and giving fibres to the inner head of the triceps."

inserted immediately beneath the inner tuberosity of the humerus, and above the terminal portion of the *latissimus dorsi*, and is also fused at origin with the tendon of the single (*coracoid*) head of the biceps. In *Hystrix* the *coraco-brachialis* has no communication whatever with the *biceps*, which is single-headed in this rodent. It is represented by the *middle* and *long* varieties of Wood. At about the level of the middle of the tendon of the *latissimus dorsi*, the muscle is pierced by a nerve ("perforans Casserii"?) which bores through the fleshy portion on the inner side of the median tendon of the muscle, passes behind this latter, and emerges at its outer side, through the muscular substance, to run across to the posterior part of the biceps. From immediately below the lower edge of the tendon of the *latissimus dorsi* the muscle takes insertion into the humerus, its inserted part being prolonged as far as the inner condyle, just above the origin of the *epitrochleo-anconeus*. That portion of this muscle which is cut off by the nerve at its emergence, and which is inserted immediately below the tendon of the *latissimus dorsi*, may be regarded, I think, as the representative of the *middle* or ordinary variety, the rest of the muscle, from this point downwards, representing the *long* variety.

Professor Rolleston has pointed out to me this muscle in the Tenrec (*Centetes ecaudatus*). It was represented by both *short* and *long* varieties, and was, moreover, quite distinct from the *biceps* for its whole length.

Meckel, I find, describes only the *long* variety of the *coraco-brachialis* as present in the "Tatu."[1] Cuvier, too, represents this variety alone in his figures of the myology of *Dasypus sexcinctus*.[2]

Biceps.—A single-headed muscle, arising by a strong flat tendon from the superior edge of the glenoid cavity of the humerus, immediately external to the root of the coracoid process of the scapula, being completely covered by the terminal portion of the *supraspinatus*. It then passes through a deep groove, excavated in the anterior face of the humerus, between the two tuberosities, which is converted into a complete foramen by the bridging over of its channel by a strong broad ligament stretched between the tuberosity piers on either side.

Soon after its emergence from the above groove, the biceps gradually loses its tendinous character, gradually, too, swells out laterally, and at the middle of the arm attains its greatest size, becoming somewhat ampulliform in shape. From this point it, by degrees, diminishes, and receives, immediately below the same, on its inner side and posterior aspect, those fibres of the *coraco-brachialis* which are not continued to the supracondyloid ridge. At a short distance from its termination, it divides into two tendons, or rather its very short single tendon splits into two branches, the outer of which is inserted into the palmar aspect of the neck of the radius, and the inner into the fossa scooped out of the radial edge of the ulna, and overhung by the coronoid pro-

In *Martes abietum*, among Carnivora, according to the same authority, "The *coraco-brachialis* has an accessory muscle inserted next between the *subscapularis* and *teres major*."

According to Meckel, however, this muscle is entirely wanting in the Kangaroo; but in the Opossum it is very short, and is attached to the upper sixth of the humerus.—*Op. cit.* p. 515.

[1] *Op. cit.* p. 514.

[2] *Op. cit.* pl. 260.

cess, in company with the tendon of insertion of the *brachialis anticus*, which is fixed slightly anterior to it and to its outer side.

Meckel makes no mention of the termination of this muscle in *Dasypus*, but remarks that its ordinary head, which is very short, receives on its inferior aspect a much slighter offset from the *coraco-brachialis*. In the Anteater, according the same anatomist, the long head soon divides into two branches, the anterior of which is inserted into the radius, while the posterior terminates at the ulna, after fusing with the *brachialis anticus*[1]. In *Macropus ruficollis* (var. *Bennetti*) this muscle, which is single-headed, divides at the termination of the upper third of the arm into two equal-sized factors, the anterior of which arises from the inner (or superior, as it lies in the bicipital groove) edge of the tendon; while the inner branch, into which is continued a rounded moderately thick tendon, arises from the inferior or outer edge, of which this rounded tendon is a continuation. The anterior division, at the inferior third of the arm, takes an external position, and is finally inserted by a broad tendon into the neck of the radius; while the posterior, occupying the inner position, terminates at the ulna.

Meckel describes this muscle, in *Macropus giganteus* ("Riesenkänguruh"), as dividing —the superficial division passing to the radius, the deeper to the ulna, where is also inserted the *brachialis anticus*, quite distinct, however, from the former muscle. In the Opossum, according to the same anatomist, the reverse takes place, the muscle consisting of two heads above, which soon unite lower down into one thick belly[2].

Mr. Mivart describes, in *Echidna hystrix*, the existence of an ulnar as well as a radial termination to the *biceps*[3]. In the Ornithorhynchus, on the other hand, according to Meckel[4], both heads of this muscle "setzen sich vereinigt sehr günstig Behufs des Schwimmens an die Mitte der Speiche." According to Mr. Mivart, the *biceps* of *Iguana tuberculata*, among Lacertilia, has an insertion into both radius and ulna[5].

Dr. Macalister, in a recent paper, states that the *biceps* is single-headed in *Dasypus septemcinctus*, but also remarks, in a foot-note, that both he and Dr. Haughton have examined Armadillos (species not given) in which this muscle has two heads[6].

Brachialis anticus.—This muscle, which is not figured by Cuvier in his plates of the myology of the Armadillo, is of considerable size and length, having a very high origin. It arises, by a completely fleshy origin, from the neck of the humerus, posteriorly and externally, in the space intervening between the roots of the two tuberosities of the bone, being completely covered at origin by the thin tendinous origin of the outer head of the *triceps*. It also arises from the whole external aspect of the humerus, included between its anatomical neck and the groove of the musculo-spiral nerve, besides implanting a few fibres in the outer and anterior overhanging edge of the large deltoid trochanter. It then passes, having close to its inferior edge the musculo-spiral nerve, also the extensive origin of the *extensor carpi radialis* on its outer side and the *biceps* on its inner, into

[1] *Op. cit.* p. 520.

[2] *Op. cit.* p. 522.

[3] Trans. Linn. Soc. vol. xxv. p. 386.

[4] *Op. cit.* p. 520.

[5] Proc. Zool. Soc. June 1867.

[6] "On the Homologies of the Flexor Muscles of the Vertebrate Limb," Journ. of Anat. and Phys. 2nd ser. (Cambridge, 1868) vol. i. pp. 285 and 289. The *seven*-banded specimen which I examined at Oxford had but a single-headed *biceps*.

the forearm, between the two prongs of the forked tendon of insertion of the latter muscle, to be inserted into a fossa in the ulna, overhung by the coronoid process of this bone, a little anterior to, and to the outer side of, the insertion of the ulnar division of the tendon of the *biceps*.

This muscle, according to Meckel, is, in the Anteater, fused with the olecranal division of the *biceps*. Its insertion is, in the *Platypus*, according to the same author, confined to the radius[1].

The *brachieus internus* is, according to Rapp, absent in *M. tamandua*[2].

Triceps.—A well-developed, and, apparently, very powerful muscle, made up of the following factors, which will be separately enumerated :—

1. *Scapular*.—This, the largest portion of the muscle, arises from the inferior, or lesser, spine of the scapula, along the whole of its extent; and after proceeding some distance on its course, joins the external *humeral* head of the muscle, and, in company with this, is inserted into the olecranon process, and becomes also continuous with the fascia on the outer side of the arm and forearm. Another element of this portion of the muscle, which is probably the representative of the "long" head of human-anatomy language, takes origin from the lower, or axillary, border of the scapula, from a projecting ridge situated just posterior to the neck of the bone, by a thick tendon, invested externally with muscular tissue. It has a uniform breadth, and runs in close company with the preceding element of the *scapular* factor, to share the same insertion, fusing with it near its termination.

This factor is inserted in the posterior edge of the olecranon, overlapping the insertion of the internal *humeral* head. This part of the muscle is, moreover, continuous with the fascia covering the elbow.

2. External *humeral* factor.—A strong fleshy slip, which arises by a thin tendon, encircling about half the circumference of the neck of the humerus—namely, that space which intervenes between the two tuberosities on the posterior and outer aspect of the bone. This tendon completely covers the fleshy fibres of the origin of the *brachialis anticus*, and is, moreover, overlapped on its outer aspect by those fibres of the *teres minor* which pass across to their insertion below the external tuberosity of the humerus. This factor takes origin also from nearly the whole length of the posterior edge of the ridge running from the above tuberosity to the deltoid trochanter. About one-third of the distance between its origin and insertion, it fuses with the two most posterior divisions of the *deltoid* at their point of insertion into the great trochanter of the humerus, and arches over that portion of the *brachialis anticus* which lies in the channel between the above process and the origin of the *extensor carpi radialis*. After this point it becomes continuous by its outer edge with the fascia of the arm. Its inner edge, after proceeding about two-thirds of the distance between origin and insertion, fuses with the *scapular* factor of the muscle.

3. Internal *humeral*.—A somewhat slender slip arising along the inner aspect of the humerus from immediately below the insertion of the *subscapularis* to almost the lower extremity of the posterior boundary of the supracondyloid foramen. It is inserted into

[1] *Op. cit.* p. 525.

[2] *Op. cit.* p. 48.

the posterior rounded and smooth edge of the olecranon, overlapping the insertion of the *epitrochleo-anconeus*.

4. *Anconeus*.—A very large, strong, fleshy muscle, of a triangular form, the apex uppermost. It arises from the whole of the extensive space (which may conveniently be termed "olecranon fossa") bounded at the base by the trochlea of the humerus, at the sides by the strong ridges which run from the middle of the posterior aspect of the bone to either condyle. It is inserted into the smooth triangular surface which intervenes between the posterior extremity of the olecranon and the humeral articular surface of the ulna. Some fibres, however, are prolonged along the outer aspect of the arm to blend with the origin of the *extensor carpi ulnaris*.

The last-named element of the muscle is very well represented by Cuvier in one of his plates[1].

It has been already stated, in the description of the *latissimus dorsi*, that the *dorso-epitrochlear* offset of this muscle is reinforced by some fibres which arise from the lower part of the axillary costa of the scapula, near the inferior angle of this bone. Prof. Rolleston has suggested to me that these fibres probably answer to an element of the *triceps* figured in one of Cuvier's plates of the myology of the Badger (*Ursus meles*) as a *fifth* extensor of the elbow[2], and which is formed by a differentiation of the scapular portion of the latter muscle into two fascicles, of which the most posterior is fixed at the inferior angle of the scapula. On the other hand, the *fourth* extensor, the *dorso-épitrochlien*—seeing that, in Cuvier's figure, it arises from the *latissimus dorsi*—is but feeble in this animal. The following remark occurs in the letterpress appended to the plates:—"Le Blaireau est, comme on sait, un animal fouisseur, et la disposition de ce cinquième extenseur doit augmenter considérablement la force d'extension de l'avant-bras. Dans l'Ours, cette particularité n'existe pas; mais l'extenseur scapulaire est très-puissant et s'attache à presque tout le bord inférieur de l'omoplate"[3].

In the Otter (a swimmer) the portion of the *triceps* mentioned as arising from the angle of the scapula and passing to the elbow, in the Badger, is present; but there seems to be no true *dorso-epitrochlear* offset from the *latissimus dorsi* present in this animal[4].

It has been further suggested to me by Professor Rolleston that the above-described muscular element, which arises at the inferior angle of the scapula and terminates at the olecranon, may be the *serial* homologue of a certain muscle which is present in the lower limb of some animals (the "*ilio-peroneal*," described by Mr. Mivart in a paper upon the "Myology of *Iguana tuberculata*")[5].

Epitrochleo-anconeus.—A fleshy, stout, lozenge-shaped muscle, arising from the inner condyle of the humerus, immediately behind the combined origins of the *pronator teres* and *flexor carpi radialis*, and passing obliquely backwards to be inserted into the hamular extremity of the olecranon, fusing also with the inserted portion of the *triceps*.

This muscle is figured by Cuvier, in one of his plates of *Dasypus sexcinctus*, under the name of *anconé interne*[6].

[1] *Op. cit.* pl. 259. fig. 2.
[2] *Op. cit.* pl. 100. fig. 2.
[3] *Op. cit.* pls. 81 and 82.
[4] *Op. cit.* pl. 109. fig. 1.
[5] Proc. Zool. Soc. June 1867, p. 789.
[6] *Op. cit.* pl. 260.

This muscle, the *epitrochleo-anconeus*, has had a monograph, consisting of several pages, and illustrated by three plates, devoted to it by Professor Wenzel Gruber[1]. The first plate, consisting of five figures, is devoted to the varieties of this muscle as seen in the human subject, in which it is by no means uncommon[2]. In one of these figures (fig. 5) it is represented as being made up of two distinct delicate slips, each constricted in the middle and bellying out towards origin and insertion. This differentiation of the muscle is not figured as occurring in any of the animals whose elbow-regions form the subjects of Prof. Gruber's plates; nor have I succeeded in finding such in the beasts which I have had the opportunity of examining.

Prof. Gruber describes the *epitrochleo-anconeus* among the Bruta, in the following members of the order:—*Bradypus tridactylus*, *Dasypus tricinctus*, *Myrmecophaga didactyla*, and a *Manis*, species unknown[3]; but figures that muscle only which belongs to the three-banded Armadillo[4].

To Prof. Gruber's already copious list I am able to add the names of the following animals, in which I have dissected out and made drawings of this muscle:—*M. tamandua* and *Chlolœpus didactylus* among Bruta[5], *Echidna setosa* among Monotremata[6], *Phascolomys wombata* among Marsupials, and *Hystrix* (*cristata* ?) among Rodents. In all cases the muscle had the relation to the ulnar nerve described by Prof. Gruber.

Pronator teres.—Is a triangular, very well developed muscle, fleshy and subcylindrical at its origin, from which it gradually flattens out into a ribband-like expansion, and is inserted by a broad tendon into the distal half of the radius. This muscle arises from the inner condyle of the humerus, and has an origin common with, but superior to, that of the *flexor carpi radialis*.

No portion of the muscle arose from the coronoid process of the ulna[7].

Supinator longus.—Appears to be absent.

Supinator brevis.—From a smooth surface outside a sharply prominent tubercle, external to the outer condyle of the humerus, arises a delicate fusiform muscular slip, barely three-quarters of an inch in length, which is inserted into the longitudinal ridge

[1] "Ueber den Musculus epitrochleo-anconeus der Menschen und der Säugethiere" (mit 3 Tafeln), Mém. de l'Acad. Imp. des Sciences de St. Pétersbourg, 7th ser. tome x. no. 5.

[2] In the 'Proceedings of the Royal Society' for May 1867, Mr. John Wood describes (p. 521) and figures (fig. 2) this muscle as occurring in a human male subject, and proposes for it the name "*Anconeus epitrochleauris*." Mr. Wood mentions, moreover, that he found in the tame Rabbit "a somewhat fan-shaped muscle, connecting the *epitrochlea* and the *olecranon*." Prof. Gruber figures such a muscle in the Hare (*Lepus timidus*), *op. cit.* tab. iii. fig. 2.

[3] *Op. cit.* pp. 10 and 20.

[4] *Op. cit.* tab. iii. fig. 3.

[5] It may not be amiss here to state that I have seen this muscle very well developed proportionally in a young specimen of *Tatusia novem-cinctus* (*D. peba*), which measured but five inches and a half from the tip of the snout to the root of the tail, and which had the umbilical cord still adherent.

[6] Mr. Mivart describes, but by no distinct name, this muscle as present in *Echidna hystrix*. At the conclusion of his description of the muscle, he observes—"Of course it arches over the ulnar nerve," *loc. cit.* p. 388.

[7] "Regarding the comparative anatomy of the coronoid slip, it will be found very rarely, if ever, developed in the lower animals; * * * * * it is not present in any of the Rodents which I have examined; but I have not had any opportunity of looking for its existence in any of the Edentata. It seems thus to be a muscle peculiarly human in its nature."—Dr. Macalister "On the Nature of the Coronoid Portion of the Pronator Radii teres," Journ. of Anat. and Phys. 2nd ser. (Cambr. 1867) vol. i. p. 9.

of the radius, at the junction of the proximal with the middle third of this bone, and immediately posterior and external to the insertion of the broad tendon of the *pronator teres*, widening out and becoming flatter at its termination.

This muscle is not represented by Cuvier in his plates of the myology of *Dasypus*.

Both short and long *supinatores* appear, according to Meckel, to be fused together ("verschmolzen zu seyn"). He remarks further that no muscle is given off from the humerus above the *extensores* of the hand. Under these, on the other hand, lies a much stronger muscle, which passes to the upper half of the radius, "und bloss Beuger ist." In all probability the long *supinator* is absent in this animal (*Dasypus*); and the above muscle may be, after all ("nur"), the short *supinator*[1].

Mr. Mivart and Dr. Murie, in their paper on the "Myology of *Hyrax capensis*"[2], describe as *supinator longus* a muscle which much resembles that which I have termed *s. brevis* in *Dasypus*. It is "*exceedingly* diminutive, and arises from the outer shaft of the humerus, just above the common origin of the next two muscles (*extensor carpi radialis* and *e. communis*), and is inserted into the radius near its neck."

Soemmering[3], in his description of this muscle in man, says, "Nonnumquam superior pars [humeral origin] a reliquo musculo distincta est."

Theile, moreover, states that when the two layers of which the muscle is composed are distinct, the superior head takes origin from the outer condyle of the humerus[4].

Extensor carpi radialis.—From the strong outer ridge ("supinator ridge") of the humerus arises, for the extent of nearly three quarters of an inch along its superior portion, a muscle which, after completing about half of its course, crosses over the radius, and, becoming suddenly tendinous at the distance of an inch from its insertion, passes under a ligamentous and muscular bridge into the palm. The ligamentous bridge stretches from the abrupt spinous termination of the dorsal ridge of the radius to a sesamoid lying midway between this point and the styloid process of the bone. The *extensor ossis metacarpi pollicis* forms the muscular bridge.

Two cord-like tendons are given off simultaneously by this muscle, which, before becoming tendinous, narrows more or less suddenly to a conical apex; one of these is inserted into the dorsal surface of the metacarpal of the index, while the other terminates at the same aspect of the like segment of the middle digit.

These answer respectively to the tendons of the *extensores carpi radiales, longior et brevior*, of human-anatomy language.

It is stated in Cuvier's 'Leçons'[5] that in some animals, such as the Dog, Hyæna, Hare, and the Edentata, the above muscles are fused together at their condyloid extremity, their tendons alone being distinct.

Meckel observes that the *extensor radialis brevior* is occasionally absent in man, as is the case in many mammals, in which never more than one radial *extensor* is met with. "Conformation," he continues, "dont le premier degré est la fusion complète des deux radiaux externes en un seul, dont on connaît divers exemples"[6].

[1] *Op. cit.* p. 534.

[2] Proc. Zool. Soc. April 1865, p. 340.

[3] De Corp. Humani Fabr. tom. iii. p. 267.

[4] Encyclopédie Anatomique, tom. iii. (Paris, 1843) p. 231.

[5] *Loc. cit.* p. 443.

[6] Manuel d'Anatomie Générale, tom. ii. p. 163.

Henle, moreover, says, concerning these muscles in man, that the *e. r. brevior* is occasionally absent, or has so grown together with the *e. r. longior* that this latter appears to give off two tendons [1].

Extensor ossis metacarpi pollicis.—This is a muscle of great length. It arises from the fossa included between the ridge which forms the inner boundary of the ulna and another ridge which runs down from the humeral articular surface of the bone to join the former, at the distance of about three quarters of an inch from the tip of the olecranon—also from the adjoining portion of the capsule of the joint, and from the strong interosseous septum between radius and ulna.

It then runs along the radial side of the *extensor indicis* for some distance, taking a direction obliquely towards the radial side of the carpus, and passes, also obliquely, over the radius, immediately behind the "crista-galli"-like termination of the median dorsal ridge of this bone, being bridged over by a thin ligamentous arch, which stretches from the above-mentioned terminal crest longitudinally to the median ridge, which runs from it backward. The muscle appears to derive a few accessory fibres from the radial crest, and becomes tendinous immediately upon leaving the radius for the carpus. The short tendon then passes under a fragile ligamentous bridge, stretching from a tubercle projecting from the dorsum of the scaphoid bone (?) across to the styloid process of the radius, or a sesamoid in its immediate vicinity, and is finally inserted into the base of the metacarpal of the pollex, on its radial side. Under that portion of the muscle which lies between the terminal crest of the median radial ridge and the beginning of its proper tendon, pass the two tendons of the *extensor carpi radialis* into the palm. Meckel expressly states that this muscle is absent in the "Tatu" [2].

Extensor indicis.—A narrow, flat, strap-shaped muscle, of uniform breadth, arising from the strong ridge which runs along the inner edge of the ulna, at the beginning of the distal half of the bone. It then turns suddenly inwards towards the middle line of the forearm, and, running on the radial side of the mesial ridge, which is developed upon the distal third of the dorsum of the ulna, close to the ulnar edge of the *extensor ossis metacarpi pollicis*, passes under the ligamentous bridge which crosses over the *extensor communis*, on to the dorsum of the carpus. It soon becomes tendinous; and the tendon almost at once divides into two unequal portions, the larger of which, broad and flat, passes to the base of the proximal phalanx of the index; while the smaller, slight and cord-like, terminates at the base of the ungual phalanx of the pollex.

This muscle is, for the greater part of its course in the forearm, overlapped by the *extensor communis*.

According to Meckel, the index alone in the "Tatu" receives a tendon from this muscle [3]. The same anatomist states that this *extensor* sometimes sends, but not always, a small offset to the pollex in the Beaver. Its tendon, moreover, in the Bear and Coati, among Carnivora, passes to the pollex as well as to the index.

Extensor communis digitorum.—A moderate-sized fusiform muscle, which arises from the strong ridge above the external condyle of the humerus, immediately below the origin of the *extensor carpi radialis*, with the lowermost fibres of which muscle its own

[1] Muskellehre, p. 203. [2] *Op. cit.* p. 553. [3] *Op. cit.* p. 551.

fibres are fused. It then passes obliquely, but gradually, towards the middle line of the forearm, and, upon passing on to the dorsum of the fore foot, is bridged over by a strong ligament, which crosses from the terminal crest of the median dorsal ridge of the radius to the cuneiform bone. Next, it becomes tendinous, dividing into two broad tendons, which divide dichotomously at the metacarpo-phalangeal articulation, and proceed as follows:—The outer division of the radial tendon passes to the index; the ulnar division of the same tendon, after being joined by the radial division of the ulnar tendon, to the middle digit; while the ulnar division of the latter tendon passes to the fourth (annularis) digit. Each of the divisions of these tendons passes to the root of the ungual phalanx of the digit to which it belongs.

This muscle, according to Meckel[1], passes in *Dasypus* only to the second, third, and fourth fingers—the arrangement, in fact, with the exception of the intercommunication of the three tendons, which I have just described.

Extensor annularis.—Immediately below the former muscle arises, from the strong supracondyloid ridge of the humerus, and from a strong tendinous septum which is attached to the median dorsal ridge of the ulna, a small, fusiform muscle, which does not become tendinous till when a little in advance of the *extensor communis*, after running parallel with it in the forearm.

Its tendon divides, almost immediately, into two slips, the radial of which passes to the base of the proximal phalanx of the fourth finger, while the ulnar slip is inserted into the base of the ungual phalanx of the little finger.

Extensor minimi digiti.—Having an origin similar to, but lower than, that of the last-described muscle, and fusing with the same for some little distance, passes a shorter and flatter muscle, parallel with the above, to be inserted into the dorsal aspect of the metacarpal bone or proximal phalanx of the little digit, by a tendon which has a comparatively wide expansion at its termination, and a greater length than that of the preceding muscle.

Cuvier, in one of his plates of the myology of *Dasypus*, represents the last two muscles as I have described and figured them; but the *extensor communis* has, according to his representation, but a single primary tendon, which splits, however, into three secondary divisions, passing to the index, middle, and fourth fingers. The delicate offset from the *extensor indicis*, destined for the pollex, is, moreover, not represented[2]. Meckel states that the *extensor minimi digiti* passes only to the fourth digit in the "Tatu"[3].

Extensor carpi ulnaris.—This muscle arises from the inferior termination of the strong "supinator ridge" of the humerus, immediately below, and fusing at its origin with, the lowermost fibres of the preceding muscle, also from the strong ligamentous septum which is stretched from the spinous termination of the median dorsal ridge of the ulna across to the lower extremity of the supinator ridge—and from the strong ridge which runs along the inner (or ulnar) edge of the above bone; the muscle, which is at origin of a more or less triangular shape, narrows gradually up to its tendon, which appears to

[1] *Op. cit.* p. 548.

[2] *Op. cit.* pl. 259. fig. 2.

[3] *Op. cit.* p. 549.

be inserted into the ulnar side of the base of the metacarpal of the fifth digit, a small round sesamoid being developed in the tendon at the point of insertion.

Flexor carpi ulnaris.—Is a strong fleshy muscle which arises from the internal face of the olecranon process of the ulna, immediately below the insertion of the *epitrochleo-anconeus*. Its fibres blend at first with those of the *flexor profundus* which take origin from the inner edge of the ulna, then pass straight forward to be inserted by a broad short tendon into the free extremity of the sickle-shaped pisiform bone.

Flexor carpi radialis.—This muscle arises from the inner condyle of the humerus, having a common origin with the *pronator teres*, but being placed lowermost. On leaving the forearm, through which it has passed as a slender fusiform slip, it runs through a smooth groove channelled out in the palmar aspect of the scaphoid bone and having an oblique direction towards the middle line of the hand, being arched over in this groove by a strong ligament which spans its channel, to be finally inserted into the rounded, nodular, palmar projection of a carpal bone which I may term, for convenience and distinctness' sake, *trapezio-trapezoid*[1], and becomes, also, continuous with a strong

[1] The following digression on the subject of the bones of the carpus in *Dasypus* will not, I think, be deemed irrelevant, when it is borne in mind that accuracy in description of the attachment of muscles demands and is dependent upon a previous knowledge of the nature, at all events, of those osseous structures which may either serve these as a starting-point when they enter upon their journey, or be to them a goal or "meta" on the completion of their course.

"Sieben Knochen," says Rapp, "finden sich auch bei den Schuppenthieren" (*op. cit.* p. 42); but no further description is given of these. Since, then, the number of bones falls short of the usual carpal complement by one, there must either be a complete loss, or a fusion with some other element, of the eighth unit. Careful inspection, supported by the testimony of Cuvier and Owen, shows that the latter has taken place. The former anatomist remarks, in his already quoted 'Ossemens Fossiles' (*loc. cit.* p. 127) that in *D. sexcinctus* ("l'Encoubert"), "Un seul os tient la place du trapèze et du trapézoïde;" while the following passage occurs in the monograph upon *Mylodon robustus* of the latter (Lond. 1842, p. 97 *et seq.*):—"In the only species of Armadillo (*Das. sexcinctus*) in which two of the normal carpal bones are blended into one, it is the trapezium and trapezoides which so coalesce, not the trapezium and scaphoides."

I append a description of the carpal bones of a species of *Dasypus* (*sexcinctus*?), which I drew up for my own use when dissecting the Armadillo which is the subject of the present paper.

Dorsal aspect.—

First row (beginning from radial side):—

1. *Scaphoid*: carries in front *trapezio-trapezoid* bone; articulates on ulnar side with *os lunare*.

2. *Lunar*: articulates with preceding bone on radial side, on ulnar side with *cuneiform*, in front with *os magnum*.

3. *Cuneiform*: a bone of great lateral extent articulates radially with *lunar*, on ulnar side with a small sesamoid, posteriorly with *ulna* and elongated *pisiform*, anteriorly with *unciform*. It carries, moreover, the metacarpal of the fifth digit.

4. *Pisiform*: is wedged in, palmad, between *ulna* and *cuneiform*. The first two bones of the above row of the carpus articulate posteriorly with the *radius* in the usual manner.

Second row (beginning radially):—

5. *Trapezium* and *trapezoid*: fused into one laterally elongated bone, which carries the metacarpals of the pollex and index, and articulates posteriorly with the *scaphoid*, and on the ulnar side with the *os magnum*.

6. *Os magnum*: carries metacarpal of middle digit only. It articulates posteriorly with the *lunar* principally, slightly with the scaphoid, with *unciform* on ulnar side, radially with *trapezio-trapezoid*.

7. *Unciform*: carries fourth digit only; articulates posteriorly with *cuneiform*, radially with *os magnum*, on ulnar side partly with *cuneiform*, partly, but slightly, with fifth digit, which is supported mainly by *cuneiform* bone.

ligament passing from the above projection to the palmar boss of the os lunare and the ulnar margin of the scaphoid groove.

Flexor sublimis digitorum.—This muscle, which appears to be combined with the *palmaris longus* both homologically and functionally, arises from the lowest part of the inner condyle of the humerus, in company with two heads of the *flexor profundus*, and passes forwards, muscular for some distance, to blend finally with the palmar fascia, which is attached on one side to the pisiform bone, on the other to a small sesamoid which lies alongside of the scaphoid.

Two digits only are supplied with a tendon from this muscle, namely, the index and middle digit, as Cuvier has figured, but somewhat indistinctly, in one of his plates of *Dasypus*[1].

According to Meckel, however, the superficial *flexor* in the "Tatu" divides into three muscles—one for the pollex and index (the tendon of which previously splits deeply), one for the third, and the remaining factor for the fourth digit[2].

Theile, in noticing varieties of the *palmaris longus* in the human subject, observes that its absence is sometimes supplied by a tendon of the *flexor sublimis*[3].

Flexor profundus digitorum.—An enormously powerful and complex muscle, made up of several elements—which may, however, be considered under two divisions, which are as follows :—

1. A large muscular mass which arises from the whole of the internal face (or palmar aspect) of the ulna, from the olecranon to within a short distance of the carpal extremity of the bone.

After proceeding a little more than halfway on its course, it is joined, having already become tendinous, by a smaller, but still considerable muscular slip, which takes rise from the inferior surface of the inner condyle of the humerus, in company with the origin of the *flexor sublimis* and another slip of the deep *flexor* presently to be described. The slip proceeding from the inner condyle is, soon after its origin, joined by another muscular mass, which arises from the coronoid process of the ulna, from the interosseous septum (between these two heads the ulnar tendon of the *biceps* and the tendon of the *brachialis anticus* dip down towards their insertion), and from the radial edge of the ulna. All these elements of the first muscular mass are continuous with an enormous tendon, in which, at the beginning of the palm, a large horseshoe-shaped sesamoid bone is developed.

2. Where the tendon joins the sesamoid, the latter is joined, but without the intervention of a tendon, by two muscular slips, the smaller of which arises from the inferior surface of the inner condyle of the humerus, in company with the superficial *flexor*, whose fibres of origin separate it from a slip which has the same origin but has been already described. On the radial side of the insertion of this slip the sesamoid is joined by a larger muscular element, which arises from the whole palmar surface of the radius, beginning at the neck of the bone, and bounded externally (that is, on its radial margin) by the insertions of the *pronator teres* and *supinator brevis*.

Between the insertions of the two above-described masses into the sesamoid there

[1] *Op. cit.* pl. 260. [2] *Op. cit.* p. 559. [3] *Op. cit.* p. 237.

terminates at this latter the tendon of a slightly flattened fusiform muscular slip, which arises from the bottom of the coronoid fossa of the humerus, and proceeds straight towards its insertion.

From the anterior extremity of the sesamoid proceed four very stout tendons to each of the four inner digits; while from its radial side, a little posterior to the origin of the above tendons, a tendon, having a much smaller diameter than these, is given off for the pollex, and is finally inserted into the base of its ungual phalanx.

Each tendon, before being inserted into a strong spinous projection at the base of the palmar aspect of the ungual phalanx of its proper digit, passes over an oval, flattened sesamoid, which lies at the junction between the ungual and preceding phalanx.

Posterior to the large sesamoid bone, a strong *retinaculum* springs up from the bottom of the sheath (regarding it from its palmar aspect) to join the deep *flexor* tendon.

Meckel states that the *flexor profundus* goes to the three outer digits; and mentions also that its tendon contains a sesamoid bone[1].

"In the Echidna, as in the Ornithorhynchus," says Mr. Mivart, "there are one or two ossicles in the palmar portion of the flexor tendon"[2].

Meckel, in his monograph upon the latter Monotreme[3], says, in the course of the description of the deep *flexor* of the fore foot, "tendine crassissimo, cujus fini inferiori duo ossicula, ad Sauriorum Dasypodumque modum, insunt."

The *Chlamyphorus* has a palmar sesamoid very much resembling in shape that of *Dasypus sexcinctus*[4]; while in *Priodontes* (*Dasypus*) *gigas* this bone is very large, and of an irregularly conical shape, the apex being directed forwards[5].

Pronator quadratus.—This muscle appears to be completely absent. It is not figured by Cuvier in his plates of the myology of *Dasypus*. Meckel notices the absence of this muscle in the "Tatu," but remarks that the *pronator teres* is well developed in compensation. He states, too, that in the Aï it is very small, perhaps smaller than in any

[1] "Ein stärker, später unstreitig verknöcherter Faserknorpel."—*Op. cit.* p. 560.

[2] "On the Anatomy of Echidna *Hystrix*," Trans. Linn. Soc. vol. xxv. p. 389. Mr. Mivart adds the following in a footnote:—"As Meckel remarks, this palmar ossicle also exists in the Armadillos; and Professor Huxley, in his last Hunterian course (for 1865), mentioned its existence in *Dasypus sexcinctus*, as also the absence in that animal of any perforated flexor, and the union of the *flexor profundus* and *longus pollicis* to form one tendon. This point of similarity between the Monotremes and Edentates is the more interesting, as my friend Mr. W. K. Parker informs me that he has discovered singular points of resemblance in the sternal structure of those two groups."

[3] *Ornithorhynchi paradoxi* Descriptio Anatomica. Fol. Lipsiæ, 1826: p. 28.

[4] This sesamoid can be seen very well, *in situ*, in the left fore foot of the skeleton of this somewhat rare Armadillo which is preserved in the British Museum. In the specimens of the same animal belonging to the Museum of the Royal College of Surgeons a similar bone is present, but has been detached and placed in front of the skeleton.

[5] This bone is described in the 'Ossemens Fossiles' (*loc. cit.* p. 128) as "très-grand, renflé en arrière en une grosse tête très-inégale, * * * * et se terminant vers la main par un corps comprimé et moins large que la tête." The sesamoid is represented by itself in figs. 12 and 13 of pl. xi. in the same work.

Rapp, in his already quoted monograph upon the Edentata, describes this bone as "besonders gross bei *Dasypus gigas*, und ist hier hinten am dicksten und hat an seiner obern Seite zwei Gelenksflächen zur Artikulation mit dem halbmondförmigen Knochen und dem *Os pisiforme*," p. 43. In pl. iv. of this monograph the bone is figured *in situ*.

This sesamoid can also be well seen in the fine skeleton of *Priodontes gigas* lately added to the valuable collection of Bruta contained in the Museum of the Royal College of Surgeons.

other beast. It has, moreover, considerably more breadth than length; and, as a slender transverse muscle, answers at most ("höchstens") to the distal eighth of the forearm[1].

Lumbricales.—These muscles, five in number, are of considerable size and length. They are slightly ampulliform at origin, and arise from the posterior part of the sesamoid bone of the *flexor profundus*, apparently from three muscular masses, one median and two lateral. The median portion arises immediately in front of the terminal tendon of that factor of the deep *flexor* which takes origin from the coronoid fossa. Only one *lumbricalis* is continuous with this, and is inserted into the ulnar side of the index finger.

The ulnar portion arises just in front of the termination at the common tendon of that portion of the *flexor profundus* which takes origin from the inner condyle, and with a few fibres of which it is continuous on the radial side of its origin. Two *lumbrical* muscles are derived from this, which pass respectively to the radial sides of the fourth and fifth digits.

From the radial portion arises a *lumbrical* muscle which passes on straight to its termination at the radial side of the index. Soon, however, after it leaves the sesamoid, it gives off a more slender slip, which passes to the underside of the pollex. Some of the fibres of this portion seem to be continuous at origin with the terminal part of the radial factor of the *flexor profundus*, which arises from the internal condyle.

It will be seen, from the above description, that the middle digit has no *lumbricales*, that the index posesses two (one on each side), that the remaining digits have one each, the pollex on its ulnar side, the fourth and fifth digits on their radial aspects.

Cuvier gives a fair representation of these muscles in one of his plates, and figures the *lumbricalis* which passes to the pollex as an offset, as I have described above, from that which belongs to the index[2]. Meckel states that the *lumbricales* in the "Tatu" are very strong and long[3].

In animals as high in the scale as the Quadrumana there appears to be some indication of the arrangement of the *lumbricales* such as exists in *Dasypus*; for, according to Church, in the Orang, Magot, and *Cebus*, these muscles "formed a fleshy mass on the palmar surface of the fused tendons" of the *flexor profundus* and *pollicis*[4].

Abductor minimi digiti.—A delicate, fusiform muscle, about half an inch in length, which arises from the pisiform bone, in advance of the insertion of the *flexor carpi ulnaris*, and is inserted into the ulnar side of either the metacarpal or first phalanx of the fifth digit.

Cuvier has given an indication, but somewhat indistinct, of this muscle, in one of his plates; but he has not attached to it any symbol[5].

Flexor brevis (or *Opponens*?) *digiti quinti.*—A strong fleshy muscle, seemingly separable into two portions; one of which arises from the stout ligament which proceeds from the palmar boss of the os lunare to the rounded nodule upon the trapezio-trapezoid bone, and is inserted into the radial side of the fused proximal and middle phalanges of the

[1] *Op. cit.* p. 532. [2] *Op. cit.* pl. 260. [3] *Op. cit.* p. 560.

[4] "On the Myology of the Orang Utang," Nat. Hist. Rev. Jan. 1862, p. 82. [5] *Op. cit.* pl. 260.

fifth digit; while the other, which is inserted into the radial side of the base of the ungual phalanx, arises from the ligament stretched between the above nodule of the trapezio-trapezoid bone and the middle digit.

This muscle is described as the internal *interosseus* of the fifth digit, by Dr. Macalister[1].

Abductor pollicis.—A short, but well-developed fusiform muscle, which arises from the palmar fascia, close to its insertion at the small sesamoid which lies to the outer side of the scaphoid bone. It is inserted into the proximal phalanx of the pollex, on its external aspect.

Opponens pollicis.—Also well developed. It is a fusiform slip, which arises just posterior to a rounded projection from the palm, probably belonging to the trapezio-trapezoid bone, and is inserted, below the preceding muscle, into the radial side of the base of the proximal phalanx of the pollex.

Flexor brevis (or *Abductor*) *pollicis.*—A muscle similar, in size and shape, to the preceding; arises just anterior to the above-described process of the trapezio-trapezoid bone, also from a strong ligamentous raphe, which passes from the above nodular projection to the base of the proximal phalanges of the index and middle digits, and from which most of the other palmar *interossei* arise. It is inserted into the base of the proximal phalanx of the pollex, on its ulnar side.

Interossei.—A muscle, broad and fleshy, arises beneath the origin of the preceding muscle, and beneath the strong ligament which stretches from the proximal phalanges of the index and middle digits to the palmar nodule of the trapezio-trapezoid bone. It is inserted, by a round strong tendon, into the base of the proximal phalanx of the index, on its palmar aspect, and is also prolonged over the radial side of the root of this digit to join the *extensor* tendon, or its sheath, by a broad tendinous expansion over the dorsum of the proximal phalanx.

This muscle, which seems to be *functionally* an *abductor indicis*, is considered by Dr. Macalister[2] to be the displaced homologue of the deep head of the *flexor brevis pollicis*.

A flattened fusiform muscle arises between the origins of the preceding and the *flexor brevis minimi digiti*, crosses obliquely the metacarpal of the middle digit, and, becoming tendinous, runs along the radial side of the fourth digit, to be inserted into the base of its ungual phalanx, on the same side. As it crosses the middle digit, it is crossed in turn by a muscle next to be described.

A muscle similar to the preceding crosses over it at right angles, as it lies over the metacarpal of the middle digit, and is inserted into the proximal phalanx of the index, on the ulnar aspect of this digit. It appears to take origin from the palmar surface of the metacarpal of the fourth digit.

In the interspace between the metacarpal bones of the index and middle digits, from the point of origin of, but at a lower level than, the *interossei* which pass respectively to the radial sides of the index and fourth digits, arises a muscle which appears to be

[1] Annals and Mag. of Nat. Hist., *l. c.* p. 318.

[2] *Loc. cit.* p. 319.

inserted into the ulnar side of the base of the proximal phalanx of the index, and to join the sheath of its extensor tendon.

A muscle, fairly strong and fleshy, arises in the interspace between the metacarpals of the middle and fourth digits, and terminates by a broad tendon on the dorsum of the former digit, joining apparently the *extensor* tendon or its sheath. The middle digit has no other corresponding muscle on its radial side.

These two last-described muscles are the only *interossei* which, from their intermetacarpal origin, can be strictly termed, according to human-anatomy language, "*dorsal*."

Dr. Macalister, in his description of the arrangement of the *interossei* muscles in the manus of *Dasypus* [1], omits to notice the fact that the fourth digit has an *interosseus* of very appreciable size, attached, as I have described, to its radial side. This muscle, moreover, is rendered the more noticeable in that it is crossed almost exactly at a right angle by a muscle of similar size and shape, which takes origin from the ulnar portion of the palm, and passes to the ulnar side of the index. The arrangement of these two muscles may be well expressed by likening them to a capital X, the legs of which are rooted in the palm, while the arms are stretched out as though to embrace the index and fourth digits.

Dr. Macalister, moreover, has not noticed that the muscular fasciculus which he has correctly described as passing to the radial side of the middle digit, is peculiar in partaking rather of the character of a *dorsal interosseus*, seeing that it has an intermetacarpal origin, while its fellows would be ranked among the *palmar* series.

Meckel describes the *interossei* as being weak in the "Tatu" [2].

Lower Extremity.—The thigh was flexed upon the side of the abdomen, and the leg upon the thigh, in such manner that when the animal was placed upon its back it appeared to lie in an exaggerated, but humanly impossible, "lithotomy position." This posture was preserved by a disposition of fascia similar to that which existed in the upper extremity.

Tensor vaginæ femoris.—A flat, thin, almost triangular, but rather irregularly shaped muscle. It arises from a process which must be regarded as the homologue of the anterior superior spine of the ilium, from the lumbar aponeurosis, external to the transverse processes of the lumbar vertebræ; also from the last of the six dorsal bands, and from the first row of scales belonging to the pelvic armature.

It is gradually lost in thin fascia, which is partly inserted into the lower surface of the third trochanter of the femur, and partly blends with that portion of the *gluteus maximus* which is inserted into the ligament passing from the above trochanter to the extremity of the ridge which runs upwards from the outer condyle. It, moreover, partly terminates in the fascia covering the outer aspect of the thigh and leg, in the neighbourhood of the termination of a muscular slip given off by one of the divisions of the *biceps*. It is overlapped during the whole of its course by the anterior free edge of the *gluteus maximus*.

Gluteus maximus is a thin and flat muscle of great extent of origin. It arises from that part of the lumbar aponeurosis which is attached to the metapophysis of the last

[1] *Loc. cit.* p. 318.

[2] *Op. cit.* p. 569.

lumbar vertebra, from the free edge of the tuberosity of the ilium, from the sacral aponeurosis which covers the longitudinal caudal muscle and the *gluteus medius*, and from the free superior edge of the ischial tuberosity.

Its fibres converge towards the third (external) trochanter of the femur, into the external face of which process they are inserted, as well as into the ligament stretched between this trochanter and the extremity of the ridge continued upwards from the external condyle.

Gluteus medius.—A well-developed, but irregularly shaped muscle, arising from the external free ridge or "crest" of the ilium, and from its posterior (or superior) fossa, and from the metapophyses of the sacral vertebræ. The sacral and iliac element fuse at the external or anterior free edge of the muscle, but enclose between them a kind of cavity or sac, which is occupied by the *pyriformis*. That portion of the muscle which arises from the sacrum is inserted into the posterior part of the summit of the greater external trochanter of the femur, and partly into the posterior intertrochanteric ridge, just external to the insertions of the *gemelli* and *obturator externus*. The factor which takes origin from the ilium terminates through a strong tendon at the anterior part of the summit of the great trochanter, which tendon is joined, shortly before insertion, by that of the *pyriformis*.

Cuvier gives a good representation of the superficial portion of the muscle in two of his plates[1].

The *Gluteus minimus* appears to be absent, and is, moreover, not figured by Cuvier.

This muscle, according to Meckel[2], is not differentiable from the *gluteus medius* in the Sloth and Anteater. Rapp, on the other hand, found all these *glutei* in *Myrmecophaga tamandua*[3].

Pyriformis.—A flat muscle, of nearly uniform breadth, arises from the anterior half of the posterior or superior margin of the oval foramen into which the great sciatic notch is converted by the articulation of the spine as well as the tuberosity of the ischium with the transverse processes of the last three sacral vertebræ, the above-mentioned margin being formed by the free edge of the processes of the middle vertebræ of the sacrum.

This muscle does not appear to have any origin from the concavity or inner face of the sacrum.

It is inserted into the summit of the great trochanter of the femur, being fused at its insertion with the strong terminal tendon of the inner layer of the *gluteus medius*.

Cuvier indicates the origin of the *pyriformis* ("pyramidal," or "sacro-trochantérien") in one of his plates[4]. The muscle appears to be separable into two portions, which, however, fuse again at its insertion.

According to Meckel[5], it consists of two elements, and is of fair size in the Platypus and Aï.

Obturator externus.—Is a fan-shaped muscle, which takes origin from the whole of the superior edge of the thyroid foramen, and is inserted by a strong flat tendon into the posterior intertrochanteric ridge, just below the digital fossa of the femur, and immediately anterior or inferior to the insertion of the *gemelli*.

[1] Pl. 259. fig. 3, and pl. 260. [2] *Op. cit.* p. 581. [3] *Op. cit.* p. 50. [4] Pl. 259. fig. 3. [5] *Op. cit.* p. 583.

The muscle has two heads of origin, the larger of which is the more anterior—the smaller, which is about one-third of the former in size, arising posterior to it, and immediately in front of the acetabulum. The sciatic nerve passes along the thigh to its outer side.

Henle[1] describes this muscle in Man as being made up of two portions at its origin.

Obturator internus.—Appears to be wanting, as might be expected, seeing that there is no lesser sciatic notch, the whole of that portion of the ischium which intervenes between its tuberosity and what must be regarded as the homologue of its spine being articulated with the sacrum.

Cuvier, moreover, gives no indication of this muscle in his plates, but states in his 'Leçons'[2] that in animals which have the ischium anchylosed with the sacrum (*e. g.* Tamandua) a muscle coming from the external face of the ischium takes the place of the *obturator internus* and the *gemelli*.

Rapp[3] notices the existence in the Tamandua of the external obturator muscle, and of a muscle which "appears to answer to the gemelli," but makes no mention of an *obturator internus*, or of a substitute for it.

In the Aï, according to Meckel[4], this muscle has left its position, and has become a second *obturator externus*, but smaller than the external obturator proper, under which it is situated. A like arrangement exists in the Anteater, which, moreover, possesses as does the Aï likewise, but one *gemellus*.

Gemelli.—Both these muscles are present, though the muscle with which they are in Man so intimately associated is absent. They are both delicate muscles, the anterior being the most slender, in that it is about one-third of its fellow in size. The former is, moreover, fusiform, while the latter is more or less fan-shaped, tapering from its origin towards its insertion.

Their origin is much further forward than in Man, owing to the great length of the ischium.

They arise immediately behind the posterior portion of the neck of the acetabulum, just above the superior border of the thyroid foramen, and are inserted into the digital fossa of the great trochanter, immediately posterior or superior to the strong tendon of insertion of the *obturator externus*.

Quadratus femoris.—Is an oblong muscle, of fair size, arising from the ramus of the ischium, immediately below the *adductor*. It passes across to be inserted obliquely into the posterior part of the rough ridge forming the anterior edge of the inner trochanter.

Cuvier figures it in profile in one of his plates[5].

It is well developed, according to Meckel, in the Aï, but is absent in the Anteater[6].

Ilio-psoas.—The two elements of this compound muscle appear to be early fused together, and are inserted along the whole edge of the inner trochanter. The iliac element takes origin from the whole inner face of the ilium.

Psoas parvus.—A long, slender muscle, which appears to arise from the outer side of the posterior edge of the last dorsal and two first lumbar vertebræ. It passes down

[1] *Loc. cit.* p. 252. [2] *Loc. cit.* p. 502. [3] *Op. cit.* p. 49. [4] *Op. cit.* p. 584.
[5] *Op. cit.* pl. 259. fig. 3. [6] *Op. cit.* p. 586.

straight, lying immediately on the inner side of the *psoas magnus*, to be inserted into a kind of tubercle ("ilio-pectineal") situated at the junction of the ilium with the pubes, immediately superior to the origin of the *pectineus*.

Pectineus.—Arises from the ilio-pectineal line of the os pubis, immediately posterior to the pubic origin of the *gracilis*. It is a thin, flat, fan-shaped muscle, and is twisted in such a manner between its origin and insertion that the surface which is superior at the former position becomes inferior at the latter—that edge, moreover, of the muscle which is anterior at origin becoming posterior at insertion, and *vice versâ*. When the thigh is completely abducted, the above appearance departs. The muscle is inserted by a flat tendon, which has a greater breadth than its cord-like representative figured in one of Cuvier's plates[1], into a roughish projection from the inner edge of the femur, situated immediately below, and slightly posterior to the spring of the "lesser" (internal) trochanter.

Its insertion lies between that of the *adductor* and the origin of the *vastus internus*.

In Cuvier's 'Leçons' it is stated that "le pectiné de la *taupe*, de *l'ours*, du *chien*, des *tatous*, des *fourmiliers* est ventru, et prolonge son tendon inférieur jusqu'au bas du fémur; cela n'est pas ainsi dans les autres mammifères." In some of these latter, together with the three-toed sloth, "ce muscle est séparé en deux portions; alors la deuxième portion prolonge également son tendon jusqu'au milieu ou même jusqu'au bas du fémur"[2].

Adductor.—This muscle, which is represented by Cuvier, in his plates[3], as the *adductor brevis*, is large, almost uniformly broad, and flat, but fleshy. It arises, its origin being completely covered by that of the *gracilis*, from the triangular bony space, formed by the junction of the os pubis and the ischium, which lies between the thyroid foramen and the symphysis pubis, and also from the ascending ramus of the latter bone for the distance of about one inch. It passes across to the femur, broadening slightly towards its termination, and is inserted obliquely into this bone at the lower part of its middle third, filling up the interval between the inserted part of the *pectineus* and the edge of the third trochanter, and having its lowest fibres of insertion continued for a small distance in advance of the above muscle. Its highest fibres of insertion are immediately below that portion of the *vastus externus* which fills the fossa included between the "greater" and third trochanter.

Though the homologies of this muscle cannot be determined with great accuracy, it may nevertheless be regarded, I think, as the representative of either the *adductor longus* or *brevis*, or, possibly, of both these muscles combined.

Meckel, when describing the *adductors*[4], makes no mention of *Dasypus*, but states that the single *adductor* in the Anteater, which coexists with a well-developed *pectineus*, is derived from three heads of origin. The Aï, moreover, although it has the latter muscle extremely well developed, has no less than four *adductors* in addition.

[1] *Op. cit.* pl. 260.

[2] Parenthetical remark by Editor, p. 505, vol. i. of 2nd edit.

[3] *Op. cit.* pl. 259. figs. 2 & 3, and pl. 260.

[4] *Op. cit.* p. 596.

Quadriceps extensor[1].—This compound muscle is made up of the following elements:—

a. Rectus.—A comparatively slender, fusiform slip, thickest in the middle, and tapering towards its origin and insertion. It arises from a smooth oval facet upon the ilium, situated immediately above, but slightly posterior to the cotyloid cavity. It takes a perfectly straight course to its insertion into the upper edge of the patella, above the points of insertion of the other components of the *extensor*.

β. Vastus externus.—A large fleshy mass, arising from the greater part of the external aspect of the femur. Its highest fibres of origin are derived from a portion of the inner face of the great trochanter, and from the outer and posterior aspect of the same tuberosity; the space, too, intervening between the third and the above-mentioned trochanter is filled up by fibres of origin of this muscle. The muscle arises, moreover, from the whole superior aspect of the third trochanter, also from the outer part of the anterior face of the rest of the femur as far as the root of the condyles. It is inserted into the superior edge of the patella, to the outer side of the insertion of the *rectus*.

γ. Vastus internus.—Is much smaller than the preceding factor; it arises from the superior and inner aspect of the femur, from the space intervening between the "greater" and "lesser" trochanters to the root of the condyles. It finds insertion at the upper edge of the patella, to the inner side of the termination of the rectus.

No distinct factor answering to the *crureus* appeared to be present.

Sartorius.—A very delicate muscle, which arises from the outer edge of the tendon of the *psoas parvus*, at the distance of about half an inch from the insertion of the latter. It passes downwards, diagonally, along the inner aspect of the thigh, as a thin, strap-like slip, and terminatesin the aponeurotic fascia which covers the inner face of the knee and leg.

This muscle would appear to play the part, in the animal to which it belongs, of a kind of *tensor fasciæ femoris internus.*

I have not found any description of a similar origin of this muscle in any other animal.

According to Meckel[2], the *sartorius* in the Aï takes origin from the aponeurosis of the *external oblique*; but this statement is contradicted by the editor of the second edition of Cuvier's 'Leçons,' who declares that the muscle in question arises from the ilium[3].

That, however, which Meckel has stated erroneously of the Sloth, takes place, if Krause's testimony be trustworthy, in the Rabbit, in which animal the *sartorius* is described as taking origin from the fascia of the *external oblique*, in the middle of *Poupart's ligament*[4].

Gracilis.—A slender, broad, but thin, wafer-like muscle, having an extensive origin and insertion. Its origin, which is shaped thus > (right side), is derived from the adjacent portions of the os pubis and ischium, from the last inch anteriorly of the superior edge of the former bone, beginning where the origin of the *pectineus* terminates, and from the first inch anteriorly of the inferior edge of the latter bone.

[1] Cuvier, Anatomie Comparée, pl. 259. figs. 2 & 3, pl. 260.

[2] *Op. cit.* p. 614.

[3] Vol. i. p. 519.

[4] Die Anatomie des Kaninchens, Leipzig, 1868, p. 116.

It passes forwards, closely embracing for about the first half of its course the large subjacent *adductor* muscle, and joins the aponeurosis (common also to the *sartorius* above and the *semitendinosus* below) which is inserted obliquely into the tibia, between its anterior ridge and the strongly developed internal lateral ligament, and becomes, moreover, continuous with the fascia covering the front aspect of the leg.

The origin and insertion of this muscle is very clearly and truthfully represented by Cuvier in one of his illustrations of the myology of *Dasypus*[1].

Semimembranosus.—A strong, uniformly broad, strap-shaped muscle, which arises from the ischium, anterior to the tuberosity of the bone, immediately below the origins of the *adductor* and the *crus penis*. It passes along the inner aspect of the thigh, to be inserted, the lower half, obliquely into the tibia, immediately posterior to and covered by, at its insertion, the internal lateral ligament, the upper half into the facet and part of the ridge on the inner aspect of the internal condyle of the femur.

The inferior edge of the muscle, near its termination, is, moreover, connected with a strong aponeurosis, common also to the *semitendinosus* and *gracilis*.

Semitendinosus.—A narrow strap-shaped muscle, arising from the tuberosity of the ischium, in close company with, but immediately posterior to, the most posterior at origin of the two divisions of the *biceps*, and passing across to the inner side of the leg. After a somewhat long course, it terminates a little above the inner malleolus in a strong aponeurosis, common to the terminal portion of the *gracilis* and *semimembranosus*, and which is attached to the strongly developed "shin-ridge" of the tibia. By its lower edge the muscle is connected with strong fascia, continuous with the inner edge of the inner division of the *gastrocnemius*, close to its insertion.

Biceps.—This muscle arises from the posterior (superior) edge of the ischium, immediately anterior to its tuberosity. It is made up of two factors, which are distinct from each other throughout the whole of their course.

The most anterior at origin arises, partly fleshy, partly distinctly tendinous, from the ischium, and, after proceeding halfway on its course, sends off, nearly at a right angle, from its upper or outer edge, a slender muscular slip, which is finally lost in the fascia covering the outer aspect of the leg, not far below the lowest portion of the *tensor vaginæ femoris*. The main part of this factor of the *biceps* terminates in the strong fascia in the neighbourhood of the heel, at a little distance above the calcaneal process.

The second division of the muscle arises slightly posterior, but superior, to the former portion, taking origin from the tuberosity itself of the ischium, and being intimately connected with those fibres of the *gluteus maximus* which have their origin at this spot. Early in its course it crosses over and passes to the inner side of its fellow, on which side it remains, up to its termination in strong fascia which is in close relation with the tendon of the outermost division of the *gastrocnemius*, separating this muscle at this point from the terminal part of the first-described factor of the *biceps*.

Cuvier represents, somewhat vaguely, this muscle as a broad triangular sheet, covering the whole of the outer aspect of the calf, and seemingly blending with its fascia[2].

[1] Anat. Comp. pl. 260.

[2] *Op. cit.* pl. 259. fig. 2.

The same anatomist figures, in his plates illustrating the myology of the Otter[1], as arising from behind the *gluteus medius*, and covered by the *G. maximus*, a very thin accessory slip of the *biceps femoris*, which, "au lieu de s'epanouir sur l'aponévrose jambière, comme le biceps, se réunit au gastrocnémien externe, et contribue à former le tendon d'Achille." This seems to answer very fairly to the last factor of the *biceps*, which I have described.

A similar accessory factor of the above muscle is figured by the same author in his plates of the anatomy of the Hyæna, and is described as a "mince et long ruban musculaire qui descend tout le long de la cuisse et va se fixer vers le milieu de la jambe, sur le fléchisseur du pouce."[2]

Gastrocnemius.—This muscle arises by two distinct heads from tubercles situated posterior to the inner and outer condyles of the femur respectively, the outermost head having the widest extent of origin.

This latter takes origin from the ridge at which the strong ligament terminates, which is attached above to the third trochanter of the femur, and overlaps, moreover, the origin of the *plantaris*.

It becomes fused with its fellow at about the lower third of the calf, and is inserted into the calcaneum on either side, by a broad aponeurotic tendon, which crosses over the slender tendon of the *plantaris* as it passes into the sole.

Soleus.—This muscle, which appears to have no tibial origin, arises from a small cavity underneath an overhanging tubercle upon the posterior part of the head of the fibula. From this origin it passes straight down, gradually and slightly broadening, to its insertion at the calcaneum, in advance of that of the *gastrocnemii*. Besides its own proper insertion, some of its fibres blend on either side with the broad tendon of insertion of the above-mentioned muscle, but have in their midst a kind of foramen for the passage of the tendon of the plantaris into the sole of the foot.

Cuvier, in his 'Leçons'[3], describes this muscle as of less considerable size in mammals than in man. According to him, it ordinarily attaches itself to the external face of the upper head of the fibula—but sometimes, however, descends to the middle part, as in the Aï and the Elephant.

Popliteus.—This is a muscle of considerable size, triangular or fan-like in shape. It arises, by two short heads, from the external condyle of the femur, immediately behind the posterior head of origin of the hindmost of the *peronei* muscles.

The lower of the two heads of origin of this muscle arises from a small depression in the external face of the articular portion of the condyle by a strong roundish tendon, which is, moreover, connected with the external semilunar cartilage. The upper and slighter of the two heads arises fleshy from a smooth facet on the condyle, situated immediately above the pit which affords origin to the first-described factor of the muscle, and is, moreover, in intimate relation with the capsular ligament of the joint. The body of the muscle spreads out, becoming flatter and thinner, to be inserted along nearly

[1] *Op. cit.* pl. 110. fig. 1.

[2] *Op. cit.* pl. 131.

[3] 2nd ed. vol. i. p. 538

the whole extent of the posterior ridge or spine of the tibia, from the neck of the bone as far as a point about half an inch above the free lower extremity of its malleolus.

For the extent of the upper half-inch of its insertion, it is overlapped by the lower half of the terminal portion of the *semimembranosus*, which muscle is, in turn, itself overlapped by the strong internal lateral ligament.

The *popliteus* bears a striking resemblance in shape to its supposed *serial* homologue in the upper limb, namely, the *pronator teres*.

Plantaris.—This muscle arises partly fleshy, partly tendinous, in company and almost fused with the outer head of the *gastrocnemius*, and immediately internal to it (the above-mentioned portion of the latter muscle completely covering it on its external side), from a roughish projection from the inferior or posterior aspect of the shaft of the femur, just superior to the inner condyle. The muscle gradually swells out from this origin to attain its greatest breadth at about the termination of the upper third of the calf; after which point it gradually tapers towards a strong tendon, which passes into the sole through a vertical groove in the calcaneal process of the heel-bone, which is arched over by the broad tendon of insertion of the *gastrocnemius*.

The tendon of the *plantaris*, besides contributing to the plantar fascia, splits, at about the level of the tarso-metatarsal joint, into three divisions, which pass respectively to the hallux, second and third digits, and are inserted into the metacarpal extremities of their respective proximal phalanges, having a mode of termination similar to that of the tendons of the *flexor sublimis* in the upper limb, in that they form a tunnel for the passage of the tendons of the deep *flexor*.

The offset passing to the hallux is very delicate, and may have been overlooked by Cuvier, since it is omitted in his plate[1].

From the inferior aspect (the foot being viewed from its plantar surface) of the tendon, before its division, a branch is given off to the fourth digit, which has an insertion similar to that of the tendons which pass to the other toes.

The above-described contributions of the *plantaris* muscle to the digits of the foot are interesting, seeing that this vicarious assumption of the office of the *flexor brevis* is exactly paralleled in the upper extremity by the fusion of the *palmaris longus* and *flexor sublimis* into one muscle.

Mr. Mivart and Dr. Murie, in their paper on the Anatomy of *Dasyprocta cristata*[2], insert a quotation from one of Prof. Huxley's Hunterian Lectures (March 20th, 1865), which refers to the *plantaris* in the Rabbit. The passage concludes thus:—"It ends in a tendon which spreads on the pulley-like end of the calcaneum, and divides into four perforated tendons, thus replacing the flexor brevis, as in *Dasypus sexcinctus*."

The editor of the second edition of Cuvier's 'Leçons' remarks[3] that in the Carnivora, in some Rodents, and some Edentates the short *flexor* exists, but its tendons are fused with that of the *plantaris*.

The following remark occurs in the same work (p. 539):—"Dans les *singes*, il (the *plantaris*) se continue manifestement avec l'aponévrose plantaire. Nous verrons plus loin que dans les autres mammifères, il tient lieu de fléchisseur perforé."

[1] Anat. Comp. pl. 260.

[2] Proc. Zool. Soc. June 1866, p. 414.

[3] Vol. i. p. 557.

Henle says of the same muscle in man :—"Er ist ein Analogon des *M. palmaris* der oberen Extremität" [1].

The *plantaris* in the Hippopotamus appears to have an arrangement similar to that of its homologue in *Dasypus* and the Rabbit; for, according to Gratiolet, this muscle terminates in the sole by four digitations, which furnish to each of the four toes a superficial flexor of the first and second phalanx[2].

The three toes of the *Hyrax*, an animal *Ungulate* in its affinities, are supplied in like manner with offsets from the *plantaris*[3].

Flexor longus digitorum.—A large fleshy muscle, which arises by two short heads, separated by the origin of the *soleus* from the whole posterior surface of the fibula, the most external head being highest and situated on the smooth external aspect of the head of the bone, just behind the origin of the most posterior of the *peronei*. It also takes origin from the interosseus membrane, and from the fibular aspect of the tibia, immediately external to the *tibialis posticus*.

At the posterior tibio-tarsal articulation it becomes suddenly tendinous, and its broad stout tendon passes immediately anterior to the insertion of the *soleus*, and close to the tibial face of the calcaneal process, into the sole; when at about the level of the tarso-metatarsal joint, it divides into five tendons of nearly equal size, each of which passes to a digit, the hallux included, those supplying the latter and the little toe being somewhat slighter than their fellows. Just before its division into the above branches, the tendon broadens, and in it is developed a flat, smooth, oval sesamoid, of less size than the corresponding ossicle in the palmar *flexor* tendon.

The following passage occurs in Cuvier's 'Ossemens Fossiles' [4] :—Dans le Cachicame [5] il y a sous le tarse une partie ossifiée du tendon des fléchisseurs comme au pied de devant; mais je ne l'ai pas observée dans le Tatou géant ni dans les Cabassous [6] et Encouberts"[7].

Flexor brevis digitorum.—This muscle was absent; but its office appeared to be assumed, as I have already stated, by the modified *plantaris*.

Tibialis posticus.—Arises by two short heads, between which the anterior tibial vessels pass into the front of the leg. The inner of these heads is attached to the upper third of the posterior face of the tibia, while the other takes origin posteriorly from that portion of the head of the fibula which is anchylosed with the preceding bone.

The body of the muscle arises from the whole length of the interosseous membrane, and, at the inner malleolus, becomes tendinous; the tendon, passing through a groove in the posterior inferior aspect of this process, enters the sole of the foot, and finally terminates at the posterior part of the strong scaphoid tubercle which projects on the inner edge of the foot. Just before its insertion, the tendon runs through a strong

[1] Muskellehre, p. 289.

[2] Recherches sur l'Anatomie de l'Hippopotame, Gratiolet, publiées par les soins du Dr. Edmond Alix. Paris, 1867 : p. 295.

[3] Murie and Mivart, "On the Myology of *Hyrax capensis*," Proc. Zool. Soc. April 1865, p. 350.

[4] Nouvelle édit., Paris, 1823, tom. v. p. 131.

[5] *Dasypus novemcinctus*.

[6] *Tatou à* 12 *bandes* (Buffon).

[7] *D. sexcinctus*.

ligamentous sling or pulley, which passes from the anterior part of the free internal edge of the malleolus to the scaphoid bone, immediately posterior to the tubercle mentioned above.

Taking origin from the middle third of the posterior aspect of the tibia, immediately below the inner head of the *tibialis posticus*, and lying between the origin of its body and the *popliteus* at its insertion, is a smaller muscle, which, at the inner malleolus, becomes tendinous, the tendon lying in the malleolar groove in company with, and to the tibial side of, that of the *tibialis posticus*.

The tendon, after its emergence from the groove, passes on to the internal slope of the dorsum of the foot, and, running over the scaphoidal tubercle, is inserted into the posterior part of an ossicle which lies immediately in front of this tubercle, alongside of the free edge of the ento-cuneiform bone. From the anterior portion of the said ossicle passes a strong tendon or ligament, to be inserted into the tibial side of the base of the proximal phalanx of the hallux.

May not the latter of the two muscles described above be regarded as a *tibialis posticus secundus vel internus*[1] ?

Cuvier figures the last-described differentiated slip as the *tibialis posticus*, while this latter is represented by him as the *flexor longus pollicis*[2].

Meckel describes a division of the *tibialis posticus* into two parts as taking place in the Beaver and Marmot, but does not record the occurrence of a like differentiation in the Bruta[3].

The same anatomist, in his monograph upon the *Platypus*[4], records the existence of a sesamoid ossicle in the tendon of the *tibialis posticus* of this Monotreme.

According to Cuvier, the tendon of this muscle contains, in Apes, a sesamoid of considerable size, placed under the scaphoid[5]. Church, however, does not record the existence of any such ossicle in the Apes he examined.

Tibialis anticus.—A muscle of fair size, which arises from the upper third of the inner face of the tibia, from the hollow arch formed by the fusion of the upper part of this bone with the fibula, from the inner aspect of the anterior ridge of the latter bone, as far as the origin of the *extensor proprius hallucis*, and from the interosseous membrane.

Passing obliquely inwards from its origin at the tibio-tarsal articulation, it becomes tendinous; and its tendon then runs close to the tibial side of, and parallel to that of, the

[1] I am glad to find that the above hint coincides with a suggestion thrown out by Mr. John Wood in a paper on "Varieties in Human Myology" read before the Royal Society, and published in its 'Proceedings' for June 1865. The passage in which this occurs (p. 11 of reprint) runs as follows:—"In many of the same feet, and in others, a sesamoid bone was likewise found in the tendon of the *tibialis posticus*, placed to the inner side of, and playing over, the scaphoid bone. Its relation to the occurrence of an additional tarsal bone in this situation in the hinder limbs of the Armadilloes and other Edentata is suggestive. The special muscle found attached to it in these animals is produced apparently by a differentiation of fibres of the *tibialis posticus*, similar to that which frequently occurs in the *tibialis anticus* in the human subject, as shown in the author's last paper read before the Society."

[2] Anat. Comp. pl. 260.

[3] *Op. cit.* pp. 636, 637.

[4] Ornithorhynchi Paradoxi Descript. Anat. (Fol. Leipzig, 1826), p. 30:—"Reliquis longe minor tendine tenui, ossiculum sesamoideum satis magnum continente, hallucis phalangi primæ inseritur."

[5] Leçons, *loc. cit.* p. 541.

muscle mentioned above—but, just before this passes into its tendinous pulley, parts company from it, and turns over the inner aspect of the ento-cuneiform bone, to be inserted into its inner or inferior edge.

Peroneus longus.—A muscle of considerable length, having but very slight connexion with the fibula. It has two heads of origin, both fleshy:—the smaller, and higher, from the outer edge of the patella, immediately above its ligament; the larger, from the arch-like ridge connecting the anchylosed upper extremities of the tibia and fibula, most of its inner fibres being intimately connected with those of the origin of the *extensor communis*; other fibres, too, arising from a strong fibrous intermuscular septum, which passes to the latter muscle from the anterior ridge of the fibula.

Upon reaching, after a straight course, the hamular projection from the outer malleolus, the muscle becomes tendinous, the tendon lying posterior in the concavity of the above process, being included, together with two other tendons, presently to be described, in a kind of synovial sheath, and being, moreover, arched over by strong fascia which passes from the malleolar process to the keel.

The tendon then dips down in front of a tubercle (the probable representative of the "peroneal tubercle" of human-anatomy language) developed upon the outer side of the anterior extremity of the calcaneum, being at this spot also arched over by strong fascia. It now, parting company from the two tendons mentioned above, passes into the sole of the foot, turning inwards sharply, almost at right angles to its previous course, and running along in the space between the cuboid and scaphoid bones posteriorly, and the bones in relation with these anteriorly, being covered by strong ligament which bridges over the intevening gap, reaches finally the outer or fibular side of the base of the metatarsal bone of the hallux.

The tendon, moreover, on reaching the sole of the foot, sends a flat offset to the tibial side of the base of the metatarsal of the fifth digit.

Peronei, brevis et tertius.—Since these muscles are, at their upper part, with difficulty to be differentiated from each other, they had best be included under one description.

The highest fibres of origin of the compound muscle proceed from the outer face of the external condyle of the femur, and from a strong flat ligamentous band which proceeds to this part of the condyle from the outer edge of the superior half of the patella. A few fibres, too, arise fleshy from the outer edge of the inferior half of the patella, immediately below the attachment to it of the above-mentioned band, being overlapped by the highest fibres of origin of the *peroneus longus*. The bulk of the muscle takes origin from the whole outer aspect of the fibula, and runs down parallel with, and close to, the preceding muscle, and shares with it the same synovial sheath, behind the outer malleolus, lying posterior and external to its tendon.

The main portion of the muscle does not become tendinous until it reaches the "peroneal tubercle" of the os calcis. Here its tendon passes under the same fibrous bridge as that which arches over the tendon of the *p. longus*, and is finally inserted into the outer face of the tubercle developed upon the inferior surface of the metatarsal of the fifth digit.

Such a termination appears to answer to that of the *peroneus brevis*.

Beginning in the muscle, about halfway down, and running for some distance in its

substance, there is present another tendon, which leaves the body of the muscle at about the level of the malleolus, and, lying first between the tendons of the *p. longus* and *brevis*, and then to the inner side of the former, but sharing the same synovial sheath, passes, superficial to, and to the inner side of these two tendons, under the fibrous bridge mentioned above, to be inserted into the outer side of the base of the proximal phalanx of the fifth digit.

This latter tendon may be regarded as a fair representative of that of the *peroneus tertius*.

Meckel notices the arrangement of the peronei in the Anteater and Aï[1]. They are described as being only two in number, long and short. In the former animal the first is described as feeble, while the second divides into two factors which pass respectively to the metatarsal and first phalanx of the fifth digit—an arrangement resembling that which I have just described as existing in *Dasypus*. In the Aï, both *p. longus* and *p. brevis* are double, the longest factor of the former muscle coming from the femur. This muscle, moreover, is not continued into the sole, but stops short at the base of the external metatarsal. The same anatomist further on describes, as present in the Anteater, a small *extensor proprius* of the fifth digit—"der dritte Wadenbeinmuskel"—which springs from the fibula, between the long and short *extensor communis*, and terminates at the fourth tendon of the former *extensor*.

A similar short *extensor proprius*, or "third peroneal," is described as existing in *Dasypus* (species not given), which comes even from the external condyle of the femur. The termination of this muscle is, unfortunately, not mentioned[2].

The editor of the second edition of Cuvier's 'Leçons' remarks[3] that in the Aï there is no *p. longus*. The *p. brevis* is a long muscle which arises from the whole length of the fibula, and above the tendon of origin of the *extensor communis*, which itself comes from the condyle of the femur. The "middle" *peroneus*, which comes but from the inferior part of the fibula, serves as the extensor of the two external digits.

Extensor communis digitorum.—Arises from nearly the whole length of the anterior ridge of the fibula, and from the outer half of the arch by which this ridge communicates with that on the front of the tibia, being in close relation at its origin with the anterior (or shorter) head of origin of the *peroneus longus*. A little above the tibio-tarsal joint it terminates in three roundish equal-sized tendons, which, after passing under a kind of annular ligament at the joint, are distributed as follows:—

The outer, or fibular, tendon divides, at the metatarso-phalangeal articulation of the fifth digit, into two branches; the outer of which passes to the terminal phalanx of this digit, while the inner joins the lateral expansion of the tendon next to be described, which this forms over the proximal phalanx of the fourth digit.

The middle tendon, a little before its division, receives, on its inferior surface and fibular side, the outer of the three divisions of the *extensor brevis*, and at the level of the tarso-metatarsal joint of the fourth digit divides into two branches, the outer of which passes to the distal phalanx of the fourth digit, receiving at its lateral expansion the

[1] Vergleich. Anat. *loc. cit.* p. 626.

[2] *Op. cit.* pp. 641, 642.

[3] *Loc. cit.* p. 542.

inner of the two branches of its fibular fellow, while its inner branch is despatched to the middle toe, there to join the expansion of its tibial comrade over the proximal phalanx of this digit.

The last or tibial tendon divides at a much higher point than do the two preceding, this division taking place at about the end of the first half of the metatarsal of the middle digit; immediately, however, before doing this, it receives on its inferior surface the middle of the three divisions of the *extensor brevis*. It then divides into two branches, the outer of which reaches eventually the distal phalanx of the middle digit, receiving, however, at its lateral expansion over the proximal phalanx of this digit, the inner branch of the middle tendon of the *extensor communis*. The second, or innermost branch of the tibial tendon reaches at last the distal phalanx of the second digit; but, at its lateral expansion over the proximal phalanx, it receives a thin, but comparatively broad band given off from the middle of the convexity of its curved offset to the tendon of the *extensor proprius hallucis*. This offset leaves the last-described branch of the tibial tendon of the *extensor communis* at the point where it diverges from the outer branch of the same tendon, and may be regarded as a third branch of the tendon. It is joined at its origin by the innermost of the three divisions of the *extensor brevis*, and, after giving off the flat band mentioned above, is continued into the tendon of the *extensor proprius hallucis*.

The *extensor communis* in the Aï, according to Meckel[1], has an amphibian peculiarity, in that it does not reach as far as the toes, but is attached by a strong single tendon to the middle of the middle metatarsal.

It is stated in Cuvier's 'Leçons' that the common *extensor* of the toes, in most Rodents and Edentates, besides other animals, takes origin by a tendon from the external condyle of the femur[2].

Cuvier's representation of the termination of the tendons of this muscle, in one of his figures of the myology of *Dasypus*, is not distinct enough to allow of the determination of its correctness or the reverse[3].

Extensor brevis digitorum.—An entirely fleshy muscle, which arises from the upper half of the whole length of the calcaneal process, on the external aspect of the bone, being bounded below by a line joining the peroneal tubercle and the free extremity of the process. It passes forwards, being arched over by a ligament which is extended between the outer malleolus and the tubercle mentioned above, and by the tendons of the *peronei* muscles, and, on gaining the dorsum of the foot, divides into three fusiform slips of equal size, which take an oblique direction from without inwards, and join two of the three tendons into which the common *extensor* divides, at a little beyond the first half of their course, and slightly posterior to their ramifications.

The outer of the three slips passes to the middle of the above tendons; the middle slip joins the inner or tibial one; while the inner slip passes to the curved transverse branch which the tibial tendon gives off to join the tendon of the *extensor proprius hallucis*.

[1] *Op. cit.* p. 641. [2] *Loc. cit.* p. 535. [3] Anat. Comp. pl. 259. fig. 2.

Cuvier, in one of his figures, gives a good representation of the origin of the *extensor brevis*; but the termination is ill-defined[1].

In *M. tamandua*, according to Rapp[2], this muscle has attachments to all five digits. Such a distribution is borne out by one of Cuvier's figures of this species of Anteater[3].

Extensor proprius hallucis.—Arises from the inner face of the fibula and from the inner edge of its anterior spine or ridge, a little above the level of the point where this bone begins to fuse inferiorly with the tibia, and below the lowest fibres of origin of the *tibialis anticus*. The muscle runs obliquely inwards, parallel with the inferior or outer edge of the *tibialis anticus*, and becomes tendinous at the level of the tibio-tarsal articulation.

The tendon, which runs parallel with that of the above muscle, courses along the inner aspect of the tarsus, passes through a tendinous loop or pulley which projects from the fibular side of the ossicle which lies immediately anterior to the prominent scaphoidal tubercle, takes a direction inclining obliquely outwards, and, broadening out, is inserted into the base of the proximal phalanx of the hallux. Just before this insertion, it sends a communicating branch to that broadened-out portion of the tibial tendon of the *extensor communis* which is inserted into the base of the proximal phalanx of the second digit. The tendon then contracts again, and, running along the dorsum of the hallux, terminates at the base of the ungual phalanx.

Plantar muscles of hallux.—From the posterior edge of the smooth oval tubercle on the fibular side of the plantar surface of the scaphoid bone arises a tendon which becomes continuous with two fusiform muscular slips; one of which passes to the sesamoid bone situated at the tibial side of the base of the proximal phalanx, while the other is continued to the distal phalanx of the hallux.

Though not strikingly homologous, these muscles may, I venture to think, be considered the representatives of the *abductor* and tibial head of the *flexor brevis* of the hallux.

They appear to be, with respect to function, opponents to the *peroneus longus*.

Plantar muscles of fifth digit.—These are three in number, and are as follows:—

α. A fusiform slip, which arises tendinous from the external, or fibular, tuberosity of the calcaneal process, and from strong fascia connected with the outer edge of this bone, and passes straight to its insertion into a strong tubercle developed upon the plantar aspect of the metatarsal of the fifth digit.

β. A muscle, somewhat broad at origin, which arises immediately to the inner side of the preceding, from the tibial, or inner, tuberosity of the calcaneal process. It gradually narrows into a long slender tendon, which is inserted into the outer (fibular) side of the ungual (middle ?) phalanx of the fifth digit, on its palmar aspect.

These muscles are probably the representatives of the *abductor* and *flexor brevis minimi digiti*.

γ. A very small and delicate muscle, which appears to take origin from the deep

[1] *Op. cit.* pl. 259. fig. 2. [2] *Op. cit.* p. 51. [3] *Op. cit.* pl. 261. fig. 1.

plantar fascia, at about the junction of the cuboid with the metatarsal bone of the fifth digit; and which is inserted into the outer side of the base of the proximal phalanx of this digit.

The true homologies of this muscle, which was so small that I nearly overlooked its presence, appear to be by no means easy of determination.

Interossei.—These somewhat delicate muscles are five in number, and radiate to their respective insertions from a common origin at the strong plantar ligament, where this crosses over the tendon of the *peroneus longus* as it passes along the sole to the hallux.

The first (innermost) of these muscles proceeds to the fibular side of the base of the proximal phalanx of the hallux.

The second and third pass one to either side of the same element of the second digit.

The fourth terminates at the tibial side of the base of the proximal phalanx of the fourth digit.

The fifth passes to the same side of the ungual phalanx of the fifth digit (*opponens digiti quinti ?*). This muscle, like the *interosseus* despatched to the corresponding digit in the fore limb, is the most considerable in size of the plantar *interossei.*

It will be seen that the middle digit possesses no *interosseus*, unless it be (which is not improbably the case) that the third passes to its tibial side. In this case the *interossei* may be regarded as abductors towards an imaginary line drawn through the intermetacarpal space between the second digit and hallux.

Lumbricales.—These muscles are no less than seven in number. They take origin from four primary stocks or trunks, which are situated in the angles of the interspaces of the five branches of the deep *flexor* tendon, at the point of divergence of these latter from the sesamoid bone imbedded in this tendon, the two middle trunks arising slightly in advance of the two outer lumbrical stocks.

The outer or fibular stock divides into two thin muscular slips; one of which passes to the tibial side of the fifth digit, whilst the other terminates at the fibular side of the fourth digit.

The next lumbrical stock, which arises in the interspace between the deep *flexor* tendons of the third and fourth digits, passes, without division, to the tibial side of the fourth digit.

The inner of the two middle stocks divides into two branches; one of which proceeds to the tibial side of the third digit, the other to the fibular side of the second digit.

The inner or tibial stock also divides into two slips, of which one proceeds to the tibial side of the second digit, the other to the fibular side of the hallux.

Of these seven *lumbricales*, the hallux, third, and fifth digits possess but one, the former on its fibular, the two latter on their tibial sides; while the second and fourth digits have one on each side.

For the bibliography of the subject with which this paper deals, and for any general remarks which I may have occasion to make thereon, I refer to a forthcoming paper upon *Orycteropus Capensis.*

EXPLANATION OF THE PLATE.

PLATE XLIV.

Fig. 1. Muscles seen upon the anterior aspect of the left arm and forearm.

S C. Subclavius.
S S. Supraspinatus.
D. Deltoid.
L D. Latissimus dorsi.
P. Pectoralis.
C B. Coraco-brachialis.
C B 3. Caraco-brachialis, "long" variety.
B. Biceps.
B A. Brachialis anticus.
E C R. Extensor carpi radialis.
E O M P. „ ossis metacarpi pollicis.
E I. „ indicis.
E C D. „ communis digitorum.
E A. „ annularis.
E M D. „ minimi digiti.
E C U. „ carpi ulnaris.
S B. Supinator brevis.
P T. Pronator radii teres.
F C R. Flexor carpi radialis.
F P D. Flexor profundus digitorum.
A B P. Abductor pollicis.
O P. Opponens pollicis.
A B I. Abductor indicis.

Fig. 2. Inner aspect of arm and forearm, left side. (Those muscles which have been already represented in the preceding figure retain the same lettering. This also applies to succeeding figures.)

S. Subscapularis.
C B 1. Coraco-brachialis, "short" variety.
T M. Teres major.
D E. Dorso-épitrochlien.
T. Triceps.
E A. Epitrochleo-anconeus.
C A L. Coraco-acromial ligament.

Fig. 3. Outer aspect of left arm and forearm.

A B. Acromio-basilar.
D 1. Deltoid, "clavicular" portion.
D 2. „ "acromial" portion.
D 3. „ "scapular" portion.
A. Anconeus.

Fig. 4. Dissection, showing deep-lying muscles on inner aspect of thigh. Left side.

G M D. Gluteus medius.
Q F. Quadratus femoris.
O E. Obturator externus.
V E. Vastus externus.
V I. Vastus internus.
R. Rectus.
A. Adductor.
P. Pectineus.
G. Gracilis.
S. Sartorius.
PP. Psoas parvus.

E P. Erector penis.

Fig. 5. Muscles seen upon anterior aspect of right leg.

T A. Tibialis anticus.
T P. Tibialis posticus.
E P H. Extensor proprius hallucis.
E C D. „ communis digitorum.
E B D. „ brevis digitorum.
P L. Peroneus longus.
P B. „ brevis.
P T. „ tertius.
* Patella.

Fig. 2

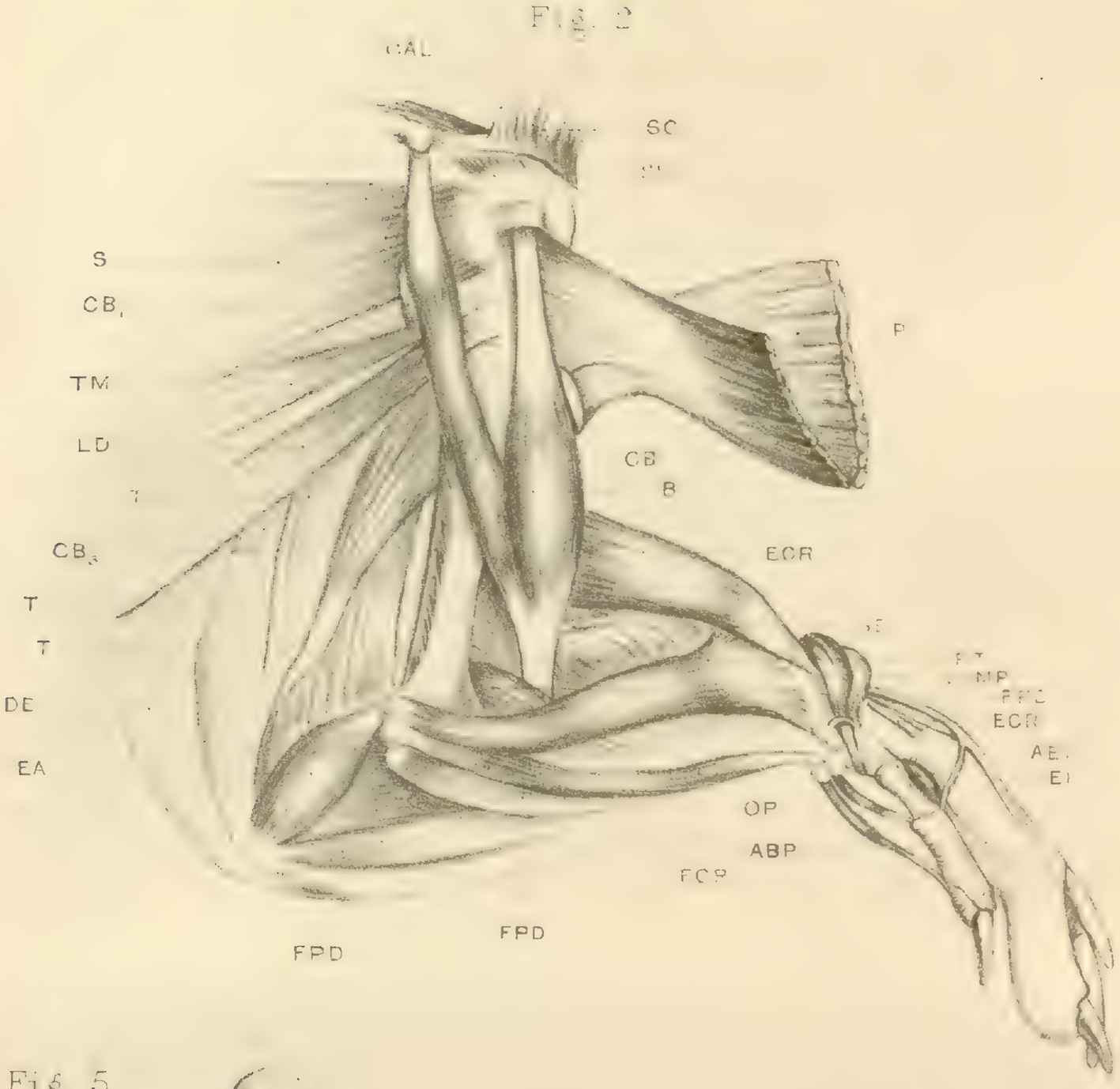


Fig. 1

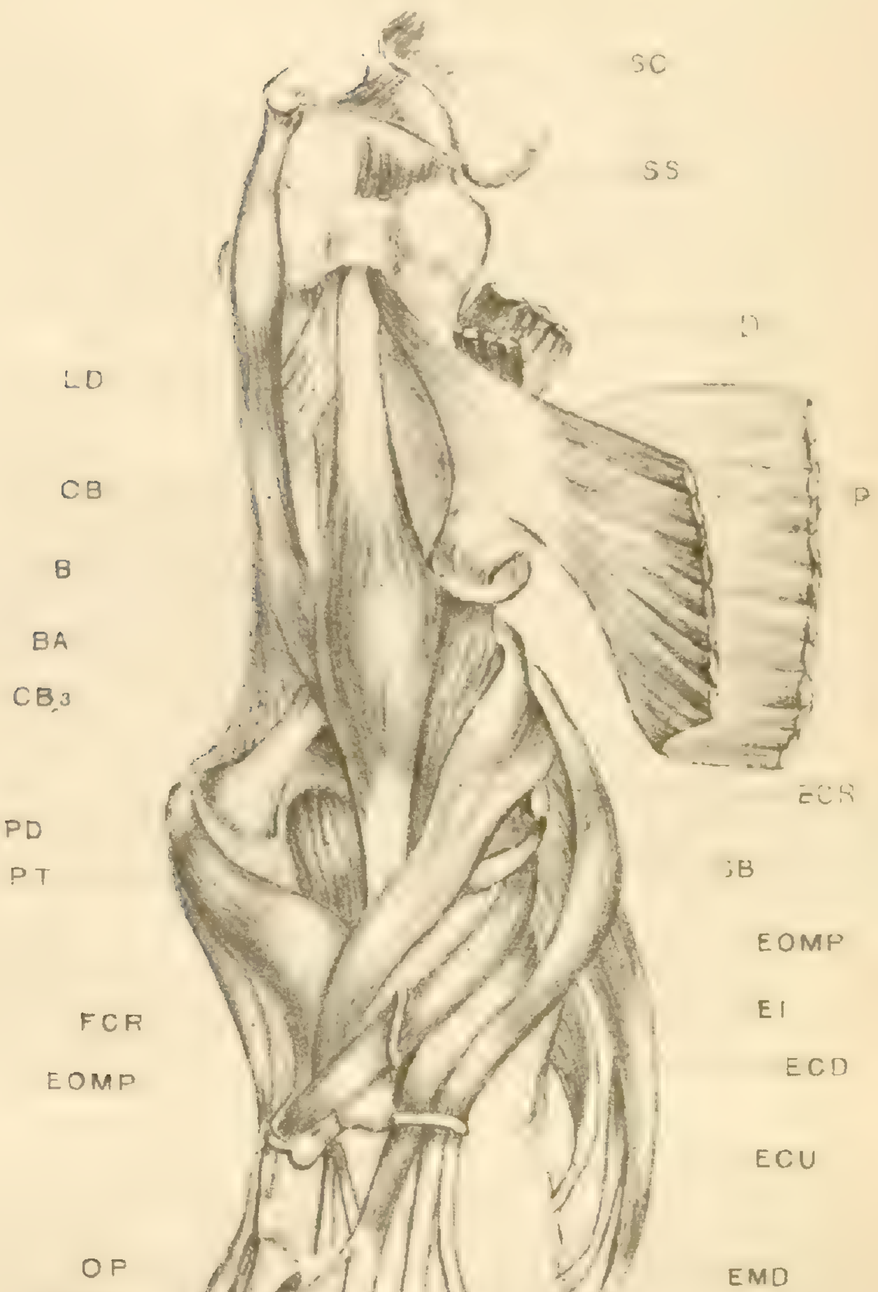
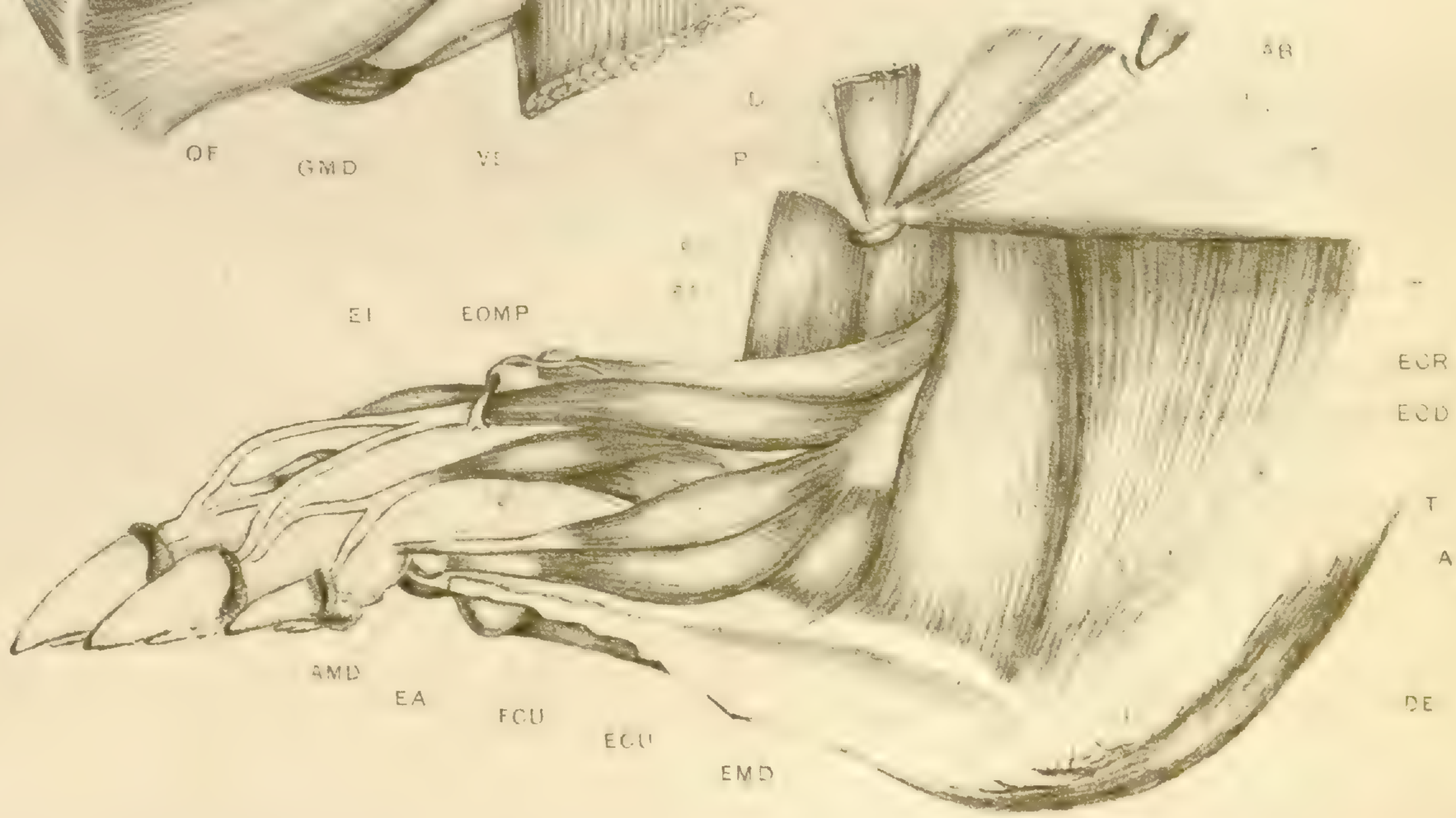


Fig. 5

Fig. 4

Fig. 3



J.C. Galton del. 1868. G.West lith.

W.West, imp.

DASYPUS SEXCINCTUS.

XII. *The Myology of the Upper and Lower Extremities of* Orycteropus Capensis.

By John Charles Galton, *Esq., M.A., Exeter College, Oxford.*

(Plates XLV. & XLVI.)

Read June 4th, 1868.

A REMARKABLY fine adult male specimen of *Orycteropus Capensis*[1] (the "Aard-vark" of Dutch colonists) having been presented to the University Museum, Oxford, by W. A. Sandford, Esq., F.G.S., of Nynehead Court, Somerset, I have been enabled, by the kind permission of Prof. Rolleston, F.R.S., to examine the muscular system of this animal.

The rarity of the beast, the great size of the specimen, and the fair condition, in most respects, of its muscles, and, finally, the hope of being able to throw even yet some light here and there upon its anatomy, since they were the reasons which encouraged me in the undertaking, are the excuses which I offer to this Society for bringing forward the results of what may appear to some a work of supererogation, seeing that a paper on the myology of the *Orycteropus*, by Prof. Humphry, of Cambridge, was published but lately in the journal which he conducts as joint editor[2].

Cuvier has the priority of Prof. Humphry in investigation of the myology of *Orycteropus*; but no complete record of his observations, if ever written, appears to be extant. He has, however, left nine figures, which are comprised in three plates, illustrating the anatomy of this animal, as a testimony of his labours[3].

The specimen which I am about to describe weighed 95 lbs. The viscera and external genitals had been removed; and it had been conveyed to England in spirit.

The principal measurements were as follows:—From tip of snout to extremity of tail, $68\frac{1}{2}$ inches; from tip of tail to lower border of pubic symphysis, 25 inches (the neighbourhood of the anus had been so involved in the incisions which had been made for the removal of the genitals, that I had no better fixed point from which to take a measurement); from labial commissure to anterior angle of eyelids, $3\frac{7}{8}$ inches; from

[1] For figures of the animal, see:—Rapp's 'Anatomische Untersuchungen über die Edentaten,' Tübingen, 1852, Taf. i.; Daniell's 'Sketches representing the native Tribes, Animals, and Scenery of Southern Africa,' London, 1820, plate ii. (the drawings, though somewhat rude, are no doubt very trustworthy, since they were taken in the country itself); Cuvier's 'Règne Animal' (Mammifères), pl. 73 (the figure here given was taken from a stuffed specimen); 'English Cyclopædia,' (Nat. Hist.) vol. i. fig. 1, art. Aard-vark.

There is a description of this animal at p. 342, vol. i. of Burchell's 'Travels in the Interior of Southern Africa' (2 vols. Lond. 1822). The vignette at the head of chap. 18, p. 446 of the same volume, represents ant-hills, one of which has been broken into at the side by the Aard-vark. The Hottentot name for this animal (*op. cit.* vol. ii. p. 424) is Takkarú.

[2] Journ. of Anat. and Phys. (2nd ser.) vol. i. p. 290. Cambridge, 1868.

[3] Cuvier, Laurillard et Mercier, 'Anatomie Comparée, recueil de planches' (fol.), pls. 254–256. Paris, 1855.

posterior angle of eyelid to anterior border of concha of ear, 4 inches; from anterior border of concha to tip of ear, 7 inches; from posterior border of calcaneum to tip of nail of middle toe (plantar surface), $10\frac{1}{2}$ inches; from anterior border of radius, or posterior border of wrist, to extremity of longest digit (dorsal measurement), $7\frac{3}{4}$ inches.

The "manus" in this animal has only four digits, the pollex being rudimentary. The homologue of the "middle" digit is the longest, the index being shorter, but of very nearly equal length. This character serves to distinguish *O. Capensis* from the only other species, *Æ. Æthiopicus*[1]. The homologue of the "fourth" finger comes next in size, the little finger being by far the shortest.

The "pes" has a large oval callosity in the centre of the sole. The heel is extremely well marked, and is, moreover, covered on its plantar aspect with a callous pad. This character, taken together with the plantar callosity, indicates obviously a plantigrade mode of progression. Such a conclusion is supported by Daniell's figures, to which reference has already been made[2].

Five digits are present, of which the middle is the longest, the second being shorter, but very nearly of the same length. The hallux comes next in size; the root of its nail is in a line with the tip of the little toe.

Upper extremity.—Though the arm is more easily abducted from the side than is the fore limb in the Armadillo described by me, the extension of the forearm from the upper arm is, nevertheless, much limited, chiefly in consequence of the attachment of the strong *platysma* along the outer aspect of the former.

I must here crave indulgence for a looseness and seeming uncertainty in my descriptions of certain muscles, seeing that I had no skeleton at hand while dissecting (a guide of which those alone know the value who have ever dissected much)—my sole osteological aid being derived from the plate of the skeleton of the *Orycteropus* contained in Cuvier's 'Ossemens Fossiles,' which I had always at my side when at work, and from a single short visit to the actual skeleton of this animal at the Museum of the Royal College of Surgeons. The more precise descriptions are founded upon more certain observations, and are, therefore, I hope, the more worthy of trust.

Musculus sternalis brutorum (or superficial layer of *panniculus carnosus*).—This is exceedingly well developed in the *Orycteropus*, and extends from the labial commissure to the lower extremity of the thorax. In the region of the head and neck its fibres are delicate and pale; but when the chest is reached, they become coarse and darker in colour, the bulk of the muscle being at the same time increased.

At the commissure of the lips the fibres of the muscle appear to diverge, forming or sending contributions to a kind of *orbicularis oris*. Thence they pass, uniform in breadth, along the buccal interspace between the upper and lower jaws; but on reaching the

[1] Rapp, *op. cit.* p. 13. Mr. Andrew Murray, however, in a "Synonymic List of Species of Mammals and their Localities," appended (p. 341) to his 'Geographical Distribution of Mammals' (Lond. 1866), mentions three species of *Orycteropus*, namely:—*O. Æthiopicus*, Sund., S. Nubia, near the White Nile; *O. Capensis*, Geoffr., Caffraria, S. W. Africa; *O. Senegalensis*, Less., Senegal.

[2] In pl. 53 of 'Shaw's Zoology' (Mammalia), vol. i. part i. (Lond. 1800), the *Orycteropus* is plainly represented as plantigrade.

cervical region, immediately after passing beyond the inferior extremity of the vertical ramus of the mandible, they spread out, and soon give off from the outer side a branch of fibres, which curve gradually outwards and downwards, and, passing over the deeper layer of the *panniculus carnosus*, are lost in the dense fibro-adipose subcutaneous tissue of the neck.

Immediately underneath the muscle, during the whole extent of its passage along the neck, lies the enormously developed submaxillary gland, the strong fibrous capsule of the latter only intervening.

On reaching the anterior border of the chest, the muscle narrows in breadth, but increases in thickness, and, passing over the insertion of the *sterno-mastoid* and manubrial portion of the *pectoralis major*, is inserted into the middle line of the sternum, from immediately below the insertion of the former muscle to about the beginning of the posterior or inferior third of the bone, its fibres meeting those of its fellow in the middle line, but not decussating with them.

A few fibres seem to be prolonged into the fascia covering the abdomen; and a few others are given off from the outer edge of the muscle, on a level with its lowest point of insertion, to be lost over the ascending fibres of the *dermo-humérien*.

Since this muscle coexists with an upward extension of the *rectus abdominis*, and with a downward prolongation of the *sterno-mastoid*, the only alternative left is to regard it, with Halbertsma, as a muscle *sui generis*, or to agree with Professor Turner[1] in considering it a differentiated portion of the *panniculus carnosus*—a conclusion in which I am inclined to concur.

Prof. Humphry, though he has given a full description and a good representation (*loc. cit.* pl. 13) of the *panniculus carnosus*[2], has not considered the factor just described in the light of its bearings upon the question of the nature and affinities of the *musculus sternalis*.

Cuvier, in his plates of the *Orycteropus*[3], gives a good representation of this muscle, under the name of "thoraco-facien." It is figured on the inner of two divisions of the *platysma*, the outer of which passes over to the external aspect of the arm and forearm, and is termed by him "dermo-humérien."

Platysma myoides.—This element of the *panniculus carnosus* is very well developed, and consists of a strong and somewhat coarse muscle, which arises from the whole extent of the inferior edge of the jugal arch and, seemingly, in part from the body of the malar bone, passes downwards and outwards over the shoulder, and along the outer aspect of the arm, to be inserted, along the radial edge of the forearm, in the fascia which clothes its external aspect. At the middle of its course it is crossed by a band of muscular fibres, which curve outwards and downwards from the outer edge of the *musculus sternalis* to be finally lost in the subcutaneous tissue of the neck.

[1] "On the Musculus Sternalis," Journ. of Anat. & Phys., Cambridge, 1857, 1st ser. vol. i. p. 246. To the animals cited by Prof. Turner in support of his views, at p. 253 in the above paper, I am able to add from my own observations *Hystrix* (*cristata*?). The muscle in question is well represented by Cuvier, under the name of "thoraco-facien," in his figures of this animal, *op. cit.* pl. 228.

[2] *Loc. cit.* p. 292.

[3] *Op. cit.* pl. 254. fig. 1, pl. 255.

A little further on, this muscle appears to enter into a more or less intimate connexion with the under surface of the *musculus sternalis*, before this latter broadens out in the cervical region.

This muscle is well represented by Cuvier[1], under the name of *dermo-humérien*.

Rhomboidei.—These are scarcely to be differentiated except by a slight difference in the arrangement of their muscular fibres, the *r. minor* being coarser in texture than its fellow. The *r. minor* takes origin from the occipital crest, and from the side of the nuchal ligament, along its whole length, and is inserted into the superior angle of the scapula, and into a very small adjoining portion of the base of the bone,

This muscle is represented by Cuvier[2] under the name of "rhomboïde du cou."

The *r. major* arises fleshy from the spine of the "vertebra prominens" (1st dorsal), and from those of the three succeeding vertebræ, also from an aponeurosis covering the deeper dorsal muscles, and covered in turn by the *trapezius*. It is inserted along the whole of the posterior costa of the scapula.

Levator anguli scapulæ.—This muscle consists of two portions, the smaller of which is a slip of uniform breadth arising from the transverse process of the atlas, beneath the origin of the *acromio-basilar*, but fused with it. It was inserted into the posterior part of the fascia covering the *supraspinatus*. The bulk of the muscle seemed to take origin from the transverse processes of the cervical vertebræ, from the second to the fifth inclusive, and was inserted into the upper angle of the base of the scapula, fusing with the superior portion of the inserted part of the *serratus magnus*, as described by Prof. Humphry[3].

The first-mentioned factor of this muscle may answer, I think, to the *occipito-scapular*, which I have described as having so enormous a development in *Dasypus sexcinctus*.

Serratus magnus.—Had no peculiarities worthy of note, excepting that, besides taking origin from the first eight ribs, it seemed also to arise from the transverse processes of the two lowest cervical vertebræ, assuming thus the appearance of a downward continuation of the *levator anguli scapulæ*. It is inserted into the inner aspect of the scapula, close to the basal margin.

Acromio-basilar.—This muscle, termed by Prof. Humphry[4] "cervico-humeral," arose from the transverse process of the atlas, and was inserted into the "metacromial process" (Parker) of the scapula. During nearly the whole of its course it ran in close relation to the free edge of the cervical portion (Cuvier) of the *trapezius*, and, just before insertion, was nearly fused with it.

Cuvier gives a very good representation of this muscle[5], under the designation of "acromio-" or "omo-trachélien." It may be worth noting that in this author's figure of the Armadillo[6] the symbol of a factor ("portion cervicale") of the *trapezius* is attached to the homologue of this muscle.

The *acromio-basilar* may, after all, be regarded, as Meckel long ago suggested[7], as but a differentiated portion of the *trapezius*.

Trapezius.—This muscle appeared to take origin, as far as I could ascertain without

[1] *Op. cit.* pl. 254. fig. 1, and pl. 255.
[2] *Op. cit.* pl. 254. fig. 2.
[3] *Loc. cit.* p. 299.
[4] *Ibid.* p. 298.
[5] *Op. cit.* pl. 254. fig. 2.
[6] *Ibid.* pl. 259. fig. 2.
[7] 'Syst. der vergleich. Anat.' Halle, 1828, dritt. Theil, p. 481.

the assistance of a skeleton at hand, from the lumbar aponeurosis, from the spines of the first nine dorsal vertebræ, and from the nuchal ligament, being covered at the highest point of origin, as Prof. Humphry remarks[1], by the *retractor auris*. Its anterior half is inserted fleshy into the upper edge of the anterior half of the scapular spine, being almost continued here into the scapular division of the deltoid, and having a small layer of fibres detached from its inferior surface to be inserted into the fascia covering the *supraspinatus* muscle.

The rest of the *trapezius* radiates towards an irregularly oval aponeurosis, which is inserted into the broadened-out tubercle or facet developed midway upon the spine of the scapula.

The most anterior inserted portion of the muscle is in intimate relation with the terminal part of the *acromio-basilar*.

The *trapezius* has no clavicular insertion whatever.

Omo-hyoid.—This muscle, as was the case in *Dasypus*, is absent. Prof. Humphry makes no remark concerning either its presence or absence; nor is it figured by Cuvier.

Cuvier does not mention this muscle when describing the hyoidean myology in *Dasypus*. He says, however, that in the Sloths it is entirely absent ("manque tout-à-fait"[2].)

It is remarked in Cuvier's 'Leçons'[3] that *the omo-hyoids* are wanting in the Sloths. They are described in the Anteater; but no mention is made of either their presence or absence in the Armadillo. Prof. Owen, in his description of the muscles of the tongue of the Great Anteater, makes no mention of this muscle[4]. I conclude, therefore, that it is absent in this animal.

The *levator claviculæ*, which was present in the Armadillo, is absent in Orycteropus.

Sterno-mastoid.—The bulk of this muscle had its ordinary origin from the mastoid process of the temporal bone, and was inserted along the upper edge of the manubrium sterni. On its middle third rested the principal lobe of the submaxillary gland.

Another and smaller section of the muscle took origin, or was inserted, along the whole of the middle line of the manubrium, meeting with its fellow of the opposite side—an arrangement similar to that in the *Armadillo*. It then ran along the outer edge of the first-described section of the muscle, fusing with it, but on reaching the upper part of the neck was separated from it by the jugular vein, which passed between. At the root of the ear it terminated, serving as a kind of *depressor auris*—an arrangement very clearly represented by Cuvier in one of his plates[5].

The *cleido-mastoid*, which rises beneath the above, from the mastoid process, runs along on its outer side for the greater part of its course, but, finally diverging, is inserted into the sternal half of the clavicle.

Subclavius.—This is a very well developed muscle, taking origin from the manubrium of the sternum, and from the junction of the first rib with this bone—in part, too, by

[1] *Loc. cit.* p. 298.

[2] Anat. Comp. vol. viii. p. 563.

[3] 2nd edit. Paris, 1835, tome iv. 1e partie, p. 490.

[4] "On the Anatomy of the Great Anteater," Trans. Zool. Soc. July 1854.

[5] *Op. cit.* pl. 255.

means of a slight, but distinct, downward prolongation of some of its fibres, from the terminal aponeurosis of the *rectus abdominis*, which finds insertion at the first rib.

It then passes, rolled upon itself, under the clavicle, to be inserted aponeurotically along the upper border of the acromial half of this bone, into a kind of sesamoid[1] situated just below the acromio-clavicular joint, and which is imbedded in the fibres of origin of the *deltoid*, along the acromion itself, and into the fascia covering the *supraspinatus* muscle; while a thin stratum, derived from the lower portion of the muscle, finds insertion by aponeurosis along the inner edge of the strong coraco-acromial ligament.

This mode of insertion of the *subclavius* bears great resemblance to that of its homologue in the species of *Dasypus* already described by me.

The muscle, at its insertion, is fairly represented by Cuvier in one of his plates[2].

Prof. Rolleston considers that the ventral portion of the muscle, through the intermediation of fascia covering the external surface of the acromion, can act, as in the Guineapig, upon the acromial portion of the *deltoid*.

With regard to the significance of the origin of part of the *subclavius* from the terminal tendon of the *rectus abdominis*, and its bearings upon the possible homology of the former muscle with the *levator humeri* of Birds, both detail and generalization will be found in a forthcoming paper by Dr. Rolleston "on the Homologies of certain Muscles connected with the Shoulder-joint"[3].

I could not determine with certainty, in the specimens of *Dasypus sexcinctus* which I examined, whether the lowest fibres of origin of the *subclavius* were in any wise continuous with the terminal fibres of the *rectus abdominis*, which muscle had a fleshy (instead of an aponeurotic) insertion at the first rib, at the very foot of the origin of the *subclavius*[4].

Obliquus externus.—Though not strictly a muscle of the upper limb, it may not be out of place to remark here that it extends very high over the chest, its aponeurosis here covering the *rectus abdominis* almost up to the termination of this latter. Its highest fibres of origin arise from the upper edge of the first rib, between the origin of the *sub-*

[1] I had overlooked the presence of this ossicle; but it was pointed out to me by Prof. Rolleston, who, wishing to ascertain, for the support or the establishment of an important anatomical point, the termination of the *subclavius* in the specimen which I was dissecting, subjected this muscle to a more rigid scrutiny than I had previously done. The ossicle was present on both sides. Prof. Humphry has made no mention of its existence; nor is it figured or described by Cuvier in his 'Ossemens Fossiles.' Rapp, in the osteological portion of his monograph, makes no reference to such a bone; nor is there one present, on either side, in the skeleton of *Orycteropus* at the Royal College of Surgeons.

Mr. Parker, moreover, in his monograph on the 'Structure and Development of the Shoulder-girdle and Sternum in the Vertebrata,' published this year by the Ray Society, neither mentions the presence of this ossicle in the *Orycteropus*, nor does he represent it in his figures of the shoulder-girdle of this animal (Pl. xxiii. figs. 17 and 18), though the specimen from which these were taken is described as "old."

The ossicle, if not a "sesamoid," may represent the "mesoscapular segment" described by Mr. Parker at p. 195 of the above-quoted monograph.

[2] *Op. cit.* pl. 256. fig. 5.

[3] Trans. Linn. Soc. vol. xxvi. 1868.

[4] Meckel (Vergleich. Anat. *loc. cit.* p. 453) mentions that, in the Armadillo (Tatu), the *rectus abdominis* reaches, "ohne Unterbrechung," to the first rib.

clavius (with a few fibres of which muscle it seems to communicate) and the insertion of the *scalenus*.

Prof. Rolleston has pointed out to me a similar high origin of this muscle in the Crocodile.

Meckel mentions a high origin of the *external oblique* from the first rib, as existing in the Hedgehog and Raccoon[1].

In *Dasypus sexcinctus* this muscle does not appear to arise from a point higher than the third rib, immediately posterior to the cartilage, and in advance of the insertion of the *scalenus*. In one of Cuvier's plates, however, this *external oblique* is figured as though taking origin from the first rib, immediately below the lowest fibres of origin of the *subclavius*[2].

Deltoid.—This muscle, as in *Dasypus*, consists of three distinct portions, more or less triangular in shape, which are fairly, but not extensively, developed in proportion to the rest of the muscles of the shoulder. They are as follow:—

α. *Clavicular*.—A flat, triangular, or fan-shaped slip, arising from the scapular half of the clavicle, from its inferior or anterior edge, its innermost fibres of origin being at the point of attachment of the outermost fibres of insertion of the *cleido-mastoid*. It then passes downwards, along the anterior aspect of the arm, covering at their insertion the factor of the *deltoid* next to be described, and the *pectoralis major* muscle, and becomes tendinous at the level of the lowest point of insertion of the latter. Its tendon, with the exception of a slight aponeurotic communication with the somewhat flattened and attenuated inferior portion of the tendon of the great pectoral, passes straight on, to join and become fused with that of the *biceps*, and, eventually, to share its insertion.

β. *Acromial*.—An almost entirely fleshy slip, having half the length of the first-described factor of the *deltoid*. It arises from the whole inferior edge of the acromial portion of the scapula—namely, the part included between the strong downward-looking "metacromial process" and the free extremity of the acromion. It is inserted into the strongly developed "deltoid ridge" of the humerus, immediately external or posterior to the upper half of the terminal portion of the manubrial factor of the *pectoralis major*.

γ. *Scapular*.—This arises, in part, from the flat oval facet developed upon the spine of the scapula at about the middle of its course, in part from a tendon which takes origin from the anterior half of the scapular spine, and which is also shared by the anterior fibres of insertion of the *trapezius*. Thence it passes obliquely downwards and forwards, and, on reaching the posterior edge of the "acromial" division of the *deltoid*, runs into a somewhat broad and thinly flattened tendon, which lies behind the internal face of the above division, and, fusing with it, shares its insertion.

Cuvier most distinctly figures this muscle as made up of three factors, and, moreover, gives the name "deltoïde à l'avant-bras" to that factor which I have termed "clavicular"[3]; but Prof. Humphry[4] notices only two divisions in the specimen which he has described.

Supraspinatus.—Arises from the supraspinous fossa of the scapula, and has a very broad

[1] Vergleich. Anat. *loc. cit.* p. 454.
[2] *Op. cit.* pl. 260.
[3] *Op. cit.* pl. 254. fig. 2.
[4] *Loc. cit.* p. 299.

insertion, partly fleshy, partly tendinous, into the whole of the upper part of the outer tuberosity of the humerus.

Infraspinatus.—A large muscle, having the usual origin in the fossa from which it derives its name. It is inserted into the external tuberosity of the humerus by a broad strong tendon, which, just before its termination, passes over a facet, somewhat reniform in outline, situated on the outer aspect of the tuberosity, a bursa being interposed.

Teres minor.—A short, triangular muscle, arising from the outer edge of the anterior third of the axillary costa of the scapula, and overlapping the anterior half of the origin of the "long" head of the *triceps*. It passes forwards to be inserted fleshy into the humerus, immediately below the facet mentioned in connexion with the preceding muscle. From the middle of the inferior edge of the muscle passes a strong tendon to the "metacromial process" of the scapula.

Subscapularis.—This muscle takes its usual origin from the inner surface of the scapula, and is inserted by a strong tendon into the inner tuberosity of the humerus.

Teres major.—A somewhat narrow muscle of nearly uniform width, arising from the lower third of the inner edge of the axillary border of the scapula, and being completely fused at origin with the inferior edge of the *subscapularis*, and with that posterior element of the *triceps* with which the *latissimus dorsi* is conjoined, before this latter detaches from itself the *dorso-épitrochlien*. It passes forwards, being applied closely to the tendon of the *latissimus dorsi*, to be inserted tendinously into the bicipital groove, a little below the inner tuberosity of the humerus, its tendon lying above that of the last-mentioned muscle, but being slightly overlapped by it on its lower edge.

Rapp describes in the Tamandua a fusion of the tendon of the *teres major* with the *latissimus dorsi*, before it terminates at the humerus[1].

Latissimus dorsi.—This muscle appeared to take origin from strong aponeurotic fascia attached to the lower half of the dorsal portion of the vertebral column covered by the *trapezius*, also from the lumbar fascia, from which the above muscle also takes origin, and is covered, moreover, by the ascending portion of the *dermo-humérien*, which is closely adherent to it.

Some fibres arise from the tenth, eleventh, and twelfth ribs, interdigitating with the origins of the *obliquus externus*. This costal origin does not appear to have existed in Prof. Humphry's specimen.

The muscle then passes upwards to be inserted into the inner edge of the bicipital groove of the humerus, fusing first with the lower border of the *teres major*, and detaching, just before it becomes tendinous, a large muscular contingent (the *dorso-épitrochlien*) to the elbow, which unites, before insertion, with the posterior part of the scapular division of the *triceps*. This *dorso-épitrochlien* is, moreover, joined by fibres which take origin from the inferior angle of the scapula. These will be more fully noticed in the description of the *triceps*. The *dorso-épitrochlien* is most apparent, from the outer aspect of the arm, as belonging to the *latissimus dorsi*; for, on viewing it from the inner side, it appears more like to an element of the *triceps*, with the above muscle closely applied to its inner face.

[1] *Op. cit.* p. 47.

Both the *latissimus dorsi* and the *teres major* are so intimately connected in *Myrmecophaga jubata*, that Pouchet, in his monograph upon this species of Anteater[1], thinks it necessary to describe them together. With regard to the terminal portions of these muscles, he says, "Les deux tendons se confondent en partie. Toutefois ce dernier [the *latissimus dorsi*] s'insère plus haut que le précédent sur le bord de la gouttière bicipitale."

Pectoralis major.—A muscle of large extent. Arises from the manubrium of the sternum and from the rest of the bone, in the middle line, and, besides communicating on its outer side with the *latissimus dorsi*, is continued into the abdomen, according to Prof. Humphry[2], and Cuvier's plates[3], to fuse with the *external oblique*. The wide and somewhat irregular gap in the abdominal walls of the specimen which I examined, caused by the long median incision, did not allow of any certainty of dissection or description. There was no clavicular origin.

The manubrial portion of the muscle, which has the greatest thickness, is inserted highest into the ridge running upwards from the deltoid trochanter; its inserted portion is, moreover, continuous with fascia covering the outer tuberosity of the humerus. A deeper layer of the same portion finds insertion a little to the inner side of the former, and is continuous, through the intervention of tendon, with the terminal portion of the rest of the muscle—which, in its turn, communicates at insertion with the lower part of the more superficial layer of the manubrial division, forming thus a shut sac, having the concavity upwards.

The lowest part of the tendon of insertion, which is thicker than the rest, owing to the approximation and fusion together of the walls of the above-described sac, is continued downwards to join the common tendon of insertion of the *biceps* and clavicular division of the *deltoid*.

Pectoralis minor.—A narrow, but very distinctly defined muscle, quite separable from the superjacent *pectoralis major*, though only differentiated from it by the intervention of cellular tissue, and not by any fascial stratum. It has an origin from the sternum, tendinous above and fleshy below, at about the level of the articulation of the fourth, fifth, and sixth costal cartilages with this bone. It then passes across the axillary space, running parallel with the *subclavius*, to join the upper part of the tendon of insertion of the *pectoralis major* (that part, namely, in which the deeper layer of the manubrial division of this muscle terminates)—which portion of the tendon is also continued over the shoulder, covering the tendon of origin of the *biceps*, and the tuberosities of the humerus.

Coraco-brachialis.—Is a single muscle, not complicated by any attachment to, or fusion with, the *biceps*. It is represented by the "long variety" of Wood only. Origin is taken from the superior extremity, and from along the inner edge of the coracoid process of the scapula, by a strong tendon, which, at the level of the inner tuberosity of the humerus, joins the body of the muscle—a few fibres, derived from the upper edge of the *subscapularis*, passing over it at this spot to their insertion at the above tuberosity. The muscle terminates at the inner supracondyloid ridge, its fibres being inserted into both the

[1] *Op. cit.* pp. 6 & 7, and pl. ii. fig. 1, pl. iii. fig. 1.

[2] *Loc. cit.* p. 296.

[3] *Op. cit.* pl. 254. fig. 2, and pl. 255.

anterior and posterior edges of the condyloid foramen; these diverge, however, at the internal edge, so as to leave a fissure for the passage of the median vessels and nerves. A similar arrangement has been already described by me as existing in *Dasypus*.

On the left side of the animal I found what may be regarded as an indication of the "short variety" (Wood), in the shape of a thin, flat muscular slip, which communicated with the posterior surface of the muscle by a delicate aponeurotically expanded tendon, which in part was inserted by a thin tendon into the lower portion of the inner tuberosity, in part communicated with the uppermost of the inserted fibres of the *subscapularis* by a thin expanded aponeurosis, which ran along immediately in front of the terminal portion of the bulk of this muscle.

This muscle has, according to Rapp, in *M. tamandua*, an insertion of considerable extent above the inner condyle of the humerus. It appears, also, to communicate with the short head of the *biceps*, since this author mentions the "common tendon" of these two muscles[1].

Pouchet, in his monograph upon the Great Anteater, describes and figures the "long" variety only of the *coraco-brachialis*, which muscle is fused at origin with the short head of the *biceps*[2].

Biceps.—A single muscle, but well developed. It arises by a strong flattened tendon, from the superior edge of the glenoid cavity of the scapula, immediately external to the root of the coracoid process, being covered at its origin by the terminal portion of the *supraspinatus* muscle. After passing through a fairly defined "bicipital groove," it becomes fleshy, and increases gradually in breadth and thickness till it reaches the middle of the arm, after which point it as gradually tapers towards its insertion.

Upon entering the forearm, it becomes tendinous, and receives on its outer side the tendon of the *clavicular* portion of the *deltoid*, which becomes fused with it, and is finally inserted, as a strong flat tendon, into the inferior surface of the neck of the radius.

The terminal tendon has no ulnar insertion like that possessed by its homologue in *Dasypus*.

This muscle, it will be seen, has no connexion whatever with the *coraco-brachialis* in any part of its course.

Rapp mentions the possession by this muscle, in *M. tamandua*, of a third short head, derived from the humerus, which, he says, exists in many mammals[3].

Brachialis anticus.—This muscle has an extent and position of origin similar to that of the *supinator longus* in this animal, only that it lies anterior to, and is overlapped by, the latter muscle. A few fibres arise from the inferior surface of the overhanging deltoid ridge of the humerus.

It passes into the forearm immediately behind the *biceps*, and becomes tendinous at about the level of the junction of the tendon of the *clavicular* factor of the *deltoid* with that of the former muscle. Its tendon is inserted into the ulna, immediately anterior

[1] *Op. cit.* p. 47.

[2] "Mémoire sur le Grand Fourmilier, par Georges Pouchet," I^e^ livraison (Paris, 1867), pl. iii. figs. 1, 2. Ibid.

to the coronoid process, but, as though vicariously, and as an effort compensatory for the single insertion of the *biceps*, sends a small offset to terminate at the radius, immediately below the tendon of the latter muscle.

This muscle is, according to Rapp [1], wanting in the Tamandua. Meckel states that, in the Platypus, it is inserted into the radius alone by a broad tendon. In the Ant-eater it is fused, he says, with the "elbow-head" of the biceps [2].

The *brachialis anticus* is inserted, according to Pouchet, into the ulna only, in *M. jubata*. This muscle, he says, "se comporte avec la longue portion du biceps comme le fait la courte portion unie au coraco-brachial" [3].

Triceps.—This muscle may be described as composed of four factors or elements, which are as follow :—

1. *External* head.—Arises from the posterior portion of the "anatomical neck" of the humerus, partly fleshy, partly tendinous, in the space intervening between the outer tuberosity and the head of the bone, overlapping here the combined origin of the preceding muscle and the *supinator longus*. It takes origin, too, from the space included between the articular head of the bone and the inner tuberosity, fusing here with the highest fibres of origin of the *internal* factor of the muscle. Halfway down it receives on its anterior free edge part of the tendon of the most posterior, or *scapular*, division of the *deltoid*. It is finally inserted into the external aspect of the long olecranon process of the ulna, fusing posteriorly, in the lower third of its course, with the anterior of the two scapular divisions of the muscle. Its anterior free edge is continuous with strong fascia covering the outer aspect of the arm.

2. *Internal* head.—This portion of the muscle takes origin from the whole posterior surface of the humerus, and from the posterior edge of the supracondyloid ridge, nearly as far as the inner condyle. It is crossed, at the junction of its upper with its middle third, by the tendon of the *latissimus dorsi*, and is finally inserted into the posterior part of the olecranon, fusing in front with the *epitrochleo-anconeus* and part of the *flexor profundus*, and behind with the offset to the elbow, derived from the *latissimus dorsi* (the *dorso-épitrochlien*).

3. Anterior *scapular* division. This, which appears to answer to the "long" head of human-anatomy nomenclature, is by far the largest element of the muscle. It arises from the anterior and middle thirds of the axillary border of the scapula, being overlapped at the first half of its origin by the *teres minor*. It is inserted into the whole of the posterior aspect of the olecranon, the outermost portion of its tendon occupying a kind of fossa at the back of the above process. At the junction of its superior with its inferior half, it is joined anteriorly by the *external* humeral head, posteriorly by the posterior *scapular* division, next to be described. On looking at this factor of the muscle from the inner side of the arm, it will be seen to be made up of two portions, the posterior of which receives into its anterior concave and semitendinous margin the posterior convex edge of the front portion.

4. Posterior *scapular* division.—Arises from nearly the whole extent of the posterior

[1] *Op. cit.* p. 48. [2] *Op. cit.* p. 525. [3] *Op. cit.* p. 10; see, too, pl. iii.

third of the axillary costa of the scapula, and soon joins the *latissimus dorsi*, at the point where this latter gives off the *dorso-épitrochlien* detachment for the elbow.

If this factor of the *triceps* be regarded from the outer aspect of the arm, it will appear to be joined at the middle third of its hinder margin by the *latissimus dorsi* as this muscle passes up towards its insertion. On surveying it, however, from the inner side, the latter muscle, just before it becomes tendinous, will be seen in intimate relation with the inner face of its middle third.

The *teres major*, as already described, is, at its origin, completely fused with this division of the *triceps*. Prof. Humphry, in his description of the *triceps*[1], states that this factor is "confluent, to some extent, with the *latissimus dorsi*."

Rapp, in the course of his description of the muscles of *M. tamandua*, remarks[2], that, besides the *triceps*, there is a longer muscle, which is, moreover, much thicker than the foregoing, and is partly covered by it. It springs from the scapula, in close company with the *teres major*, and is inserted into the olecranon. A portion of its tendon passes over to the fascia of the forearm, "die er spannen kann."

Pouchet describes[3] a similar muscle, as present in the Great Anteater, under the name of "accessoire interne" (of the *triceps*), which he regards as synonymous with a muscle represented in one of Cuvier's plates of the myology of the Tamandua (*op. cit.* pl. 261. fig. 1), under the following designation:—"Triceps, portion allant au tendon du grand dorsal, dit quatrième extenseur."

This muscle appears, from Pouchet's figures, to be the *dorso-épitrochlien*, reinforced by a scapular contingent, since some of its fibres are continuous above with the *latissimus dorsi*, while its termination is at the elbow. This author, however, regards it as "un organe qu'on pourrait à un autre point de vue rattacher au système des muscles pouciers."

Epitrochleo-anconeus.—This muscle, which is represented by Cuvier as a division of the internal humeral factor of the *biceps*[4], is very fairly developed. It arises from the strong tubercle in which the supracondyloid ridge ends, immediately above the inner condyle of the humerus, just posterior to the origin of the *pronator teres*—and terminates at the hamular projection of the olecranon, becoming first blended with the inner humeral factor of the *triceps*, and with the ulnar head of origin of the *flexor profundus*. It has the usual relation to the ulnar nerve. Cuvier represents it as too broad at its origin. Prof. Humphry describes this muscle[5], under the name of *anconeus internus*, as an element (which it certainly is) of the *triceps*; and mentions, in a foot-note, that it is synonymous with the *epitrochleo-anconeus*, "found not unfrequently in the human subject." Rapp describes this muscle, independently of the *triceps*, as occurring in the Tamandua, under the name of "anconeus parvus"[6].

A similar muscle is described by Pouchet[7] as a factor of the *triceps*, under the designation of "vaste interne." It is, according to him, "très-court et forme le pendant de l'anconé." It, moreover, "cache en partie le fléchisseur commune des doigts, il en est

[1] *Loc. cit.* p. 301.
[2] *Op. cit.* p. 48.
[3] *Op. cit.* p. 12, and pl. iii. fig. 1.
[4] *Op. cit.* pl. 256. fig. 5.
[5] *Loc. cit.* p. 301.
[6] *Op. cit.* p. 48.
[7] *Op. cit.* p. 11, and pl. iii. fig. 1.

séparé par le nerf cubital." This muscle, moreover, sends upwards from its posterior part a peculiar offset, "gros comme le doigt environ," which covers the ulnar nerve, and runs parallel with it. It then bends towards the inner border of the humerus, in its passage across the brachial vessels, and, at about the middle of the arm, is suddenly continued as a delicate tendon, which spreads out and fixes itself upon the surface of the tendon of the short portion of the *biceps*. More details of the comparative anatomy of the *epitrochleo-anconeus* will be found in my paper on *Dasypus sexcinctus*.

Pronator teres.—A strong, well-developed muscle, arising from the upper portion of the inner border of the internal condyle, immediately above the origin of the *extensor carpi radialis*. It gradually broadens outwards towards its insertion into the distal half of the radius, along the strong external or dorsal ridge of this bone.

This muscle has a great similarity to its homologue in *Dasypus*, and, like it, does not derive any of its origin from the coronoid process of the ulna [1].

Supinator brevis.—This muscle, as in *Dasypus*, had only its humeral origin; it had, however, proportionally a much better development. It was inserted along the outer, or dorsal, ridge of the radius, for fully half the length of the bone, but stopped short a little in advance of the posterior portion of the insertion of the preceding muscle.

According to M. Pouchet's description and figure, this muscle in *M. jubata* retains only its humeral origin [2].

Supinator longus.—This muscle, which is absent in *Dasypus*, is very well represented in the forearm of the *Orycteropus*. It has a very extensive origin, from nearly the whole extent of the posterior surface of the humerus, in the middle line, beginning as high up as the neck of the bone, and terminating upon the "supinator ridge," soon after the commencement of this latter. It covers at its origin the whole extent of origin of the *brachialis anticus*, and is, in turn, at its origin, covered by the external head of the *triceps*, and, at its lowest part, by the fibres of origin of the *extensor carpi radialis*.

The muscle, having started upon its course, narrows considerably, but preserves a uniform breadth and uniform character, as a flat slip of tolerable thickness, till it reaches its insertion along the distal extremity of the radius, the middle portion being inserted by a tendon into the strong tubercle in which the dorsal [3] ridge terminates, while the lateral portions are lost in a kind of aponeurosis, which covers the tendons of the principal *flexors* as they pass into the region of the carpus, and is also extended as a kind of fascia over the dorsum of the wrist. The outer half, moreover, of its terminal portion is fused with the annular ligament, which bridges over the three tendons of the *extensor communis* as they pass on to the dorsum of the carpus. This termination is very well represented by Cuvier in one of his plates [4].

The presence, merely, of the *supinator longus* in *M. tamandua* is mentioned in Rapp's monograph; but Pouchet makes no reference to it in his work upon the Great Anteater.

According to Meckel [5], this muscle has a very great development in the Aï, and is, in

[1] Dr. Macalister "On the Nature of the Coronoid Portion of the Pronator Radii Teres," Journ. of Anat. and Phys. 2nd ser. (Cambr. 1867), vol. i. p. 9.

[2] *Op. cit.* p. 19, and pl. ii. fig. 3.

[3] By the *dorsum* of the radius, I mean that surface which lies uppermost when the forearm is fully pronated.

[4] *Op. cit.* pl. 254. fig. 2.

[5] *Op. cit.* p. 534.

this species of Sloth, as well as in the Anteater, differentiable into two layers—an upper, the longest, and a lower, the shorter portion.

Extensor carpi radialis.—Arises fleshy from the supinator ridge, immediately below the lowest fibres of origin of the *supinator longus*, and is overlapped at the lowest half of its origin by the commencement of the *extensor communis digitorum*. After running for about two-thirds of its course, the muscle crosses the radius, and lies in a wide shallow groove between the external edge of the bone and the mesial ridge, just in front of the lowest point of insertion of the *pronator teres*. Here, too, the muscle becomes tendinous, and is crossed by the tendon of the *extensor ossis metacarpi pollicis*.

The muscle, instead of having only one tendon (as in the specimen described by Prof. Humphry [1]), has two distinct well-developed tendons, of nearly equal size, the outermost being slightly the broadest. They are inserted into the radial sides of the bases of the metacarpals of the index and middle digits respectively.

There is a slight indication of bifidity in the fleshy portion of the muscle, before it becomes tendinous.

What may be regarded as the main tendon is continued into that branch which goes to the middle digit. This, taken in conjunction with the presence of the "brevior" branch (of human-anatomy nomenclature) only, in Prof. Humphry's specimen, may indicate that the "longior" element is of secondary development.

According to Meckel [2], in the Aï, Anteater, and Armadillo this muscle is single at its origin, but eventually splits into two bellies, each of which has a proper tendon of attachment to the two first metacarpals. In the Marmot, Porcupine, Beaver, Agouti, and certain other Rodents the muscle is double for the whole of its length.

Among Marsupials, according to the above anatomist, the tendon of this muscle, in the Kangaroo, splits into two divisions, the smaller of which goes to the metacarpal of the index. In *Didelphys*, on the contrary, this muscle is entirely in two divisions, which terminate respectively at the second and third metacarpals.

Extensor ossis metacarpi pollicis.—Arises from the lower two-thirds of the strong inner ridge of the ulna, and from the space included between this and the radial border of the bone—also from the interosseous membrane, and from the neck of the radius, close to the proximal half of the inserted portion of the *supinator brevis*. The muscle passes over a shallow groove in the outer half of the distal end of the radius, where it becomes tendinous, the tendon overlying those of the *extensor carpi radialis*, and being overlain in turn by the terminal expansion of the *supinator longus* over the wrist. It terminates finally on the dorsum of the trapezium, which bone, though not a supporter of the index, is strongly attached to its radial side by a ligament.

There is no indication in the tendon of this muscle of that bifidity which takes place in its serial homologue the *tibialis anticus*. In *Dasypus*, too, as I have described, the tendon of this muscle is single.

The tendon of this muscle in the Great Anteater, which is also single, is principally inserted into the trapezium; but "quelques fibres," says Pouchet [3], "tendineuses gag-

[1] *Loc. cit.* p. 306. [2] *Op. cit.* p. 538. [3] *Op. cit.* p. 23; see, too, pl. ii. figs. 1 and 3.

nent seules la tête du premier métacarpien. Le muscle ne peut donc agir directement sur le pouce; il est, avant tout, un muscle de la station."

May not the above-described insertion of the terminal tendon principally into the trapezium, while but few of its fibres pass to the metacarpal of a pollex which, though somewhat feeble, must still be ranked among the range of digits [1], either be looked upon as the soon-to-be-cast-off appendage of an already useless member, or be regarded in the light of a preparation for a yet more rudimentary, or rather decadent, condition of the pollex, such as exists in the Orycteropus, in which animal the sole representatives of this digit are two difficult-to-be-discovered, seemingly insignificant ossicles [2]?

In the Guineapig, in which the pollex is absent, the tendon of the *extensor ossis metacarpi pollicis*, according to Mr. Mivart and Dr. Murie [3], "runs on to the base of the metacarpal of the index, though mainly inserted into the rudimentary trapezium."

According to Prof. Huxley, while the tendon only of this muscle is divided in the Gorilla, Orang, and Gibbon, this division involves the muscle itself in the Chimpanzee [4].

Soemmering has noticed in man [5], besides the simple splitting of the tendon, the actual division of the muscle itself. Theile has recorded that this muscle has sometimes been observed in man to be divided into two parts along its whole extent [6].

Extensores primi et secundi internodii pollicis.—These muscles are, as might be expected, absent.

Extensor indicis.—Arises from the middle third of the strong internal ridge, or margin, of the ulna, immediately anterior to the insertion of the external portion of the *triceps*, lying, also, immediately to the outer side of the *extensor ossis metacarpi pollicis*, at the origin of this latter.

After this, it rapidly narrows, and its tendon, on reaching the articulation of the radius and ulna, runs under a ligamentous bridge stretching between the adjacent corners of the extremities of these bones, and passes on to the dorsum of the hand, underneath the three branches of the common *extensor* tendon. At a short distance from its termination, it divides into two slips, which are inserted into the bases of the proximal phalanges of the index and "middle" digit respectively.

Extensor communis digitorum.—Arises from the lower part of the "supinator ridge" of the humerus, overlapping here the lower half of the origin of the *extensor carpi radialis*—also from the tubercle upon the external condyle, which gives origin to the *supinator brevis*, being fused at this point of origin with the *extensores annularis* and *minimi digiti*.

Shortly before it arrives at the distal extremity of the radius, the muscle divides into two bellies, which become tendinous on passing under the annular ligament common to them and to the tendon of the *extensor indicis*. The ulnar tendon, at the carpo-metacarpal

[1] Pouchet remarks, in a kind of preface or introduction, *op. cit.* p. 3, "Le premier doigt est grêle, un peu détaché des autres, mobile. On peut lui donner le nom de *pouce*."

[2] Cuvier says, "Le premier os du second rang [of the carpus] est un trapèze auquel s'attachent deux très-petits os, seuls vestiges du pouce."—*Ossemens Fossiles* (nouvelle édit. Paris, 1823), tome v. p. 135.

[3] "On the Anatomy of the Crested Agouti," Proc. Zool. Soc. June 1866, p. 404.

[4] Lect. Coll. Surg. See Med. Times and Gazette, 1864.

[5] De Corp. Humani Fabr. vol. iii. p. 239.

[6] Encyclop. Anat. (Paris, 1843), tome iii. p. 232.

articulation of the foot, splits into two branches, which terminate at the ungual phalanges of the "fifth" and "fourth" digits respectively. The radial tendon also splits into two branches, at a similar articulation to that at which the ulnar divides, which terminate respectively at the ungual phalanges of the index and "middle" digits.

The radial branch of the muscle, moreover, detaches from its ulnar side, on becoming tendinous, a somewhat slight tendinous slip, which passes to a short transverse band, by which the ulnar and radial tendons communicate before they each split into two branches.

The somewhat slender tendon of the *extensor indicis* passes beneath the tendons of the *extensor communis* as they run under the bridge formed by the annular ligament; and the radial branch of the *extensor annularis*, which passes to the middle digit, appears to communicate with the inferior surface of the ulnar tendon of the *extensor communis*.

Cuvier represents this muscle as giving off, upon its emergence from under the terminal expansion of the *supinator longus*, three equal-sized tendons, which pass to the index, "middle," and "annularis" digits respectively[1].

In Prof. Humphry's specimen[2] there were "four tendons derived from two bundles of muscle," &c.

Extensor annularis.—Arises from the upper portion of the external condyle of the humerus, immediately below, and in conjunction with, the common *extensor*. It then runs between this muscle and the *extensor minimi digiti* as far as the beginning of the carpus, and becomes tendinous at the level of the carpo-metacarpal joint of the digit from which it derives its name, and at this point runs under a delicate ligamentous bridge.

The tendon then passes under the ulnar division of the *common extensor* tendon, dividing here into two branches, one of which passes to the ulnar side of the base of the proximal phalanx of the third ("middle") digit; while the other courses along the ulnar side of the fourth ("annularis") digit, and, after sending downwards an offset at the level of the base of the proximal phalanx, which is joined by an *interosseus* muscle occupying the intermetacarpal space between the fifth and the above digit, is continued onwards to the base of the distal phalanx.

Cuvier represents[3] the tendon of this muscle as dividing into two branches, the radial of which passes beneath the ulnar division of the *common extensor* tendon to the ulnar side of the "middle" digit; while the ulnar branch runs to the "fifth," and not to the "fourth" digit.

Neither the branch to the "middle" digit nor the communication with the *interosseus* appears to have existed in Prof. Humphry's specimen[4].

I have described a muscle similar to the above as present in *Dasypus sexcinctus*.

Extensor digiti minimi.—A fusiform muscle, which arises from the external face of the outer tuberosity of the humerus, immediately below the origin of the *extensor annularis*, and above that of the *extensor carpi ulnaris*, with which muscle it is fused for the first half of its course. It does not become tendinous till it nearly reaches the extremity of the ulna; here its tendon passes to the radial side of a tubercle which lies at about the

[1] Anat. Comp. pl. 254. fig. 2.
[2] *Loc. cit.* p. 307.
[3] *Op. cit.* ibid.
[4] *Loc. cit.* p. 307.

middle of the distal margin of the bone, and is here bridged over by a distinct, but very delicate ligament, which is attached to the above tubercle. Near its termination the tendon broadens, and, crossing over that of the *extensor carpi ulnaris*, is inserted, partly into the base of the proximal phalanx of the fifth digit, partly into a sesamoid ossicle situated at the ulnar side of this phalanx, and partly, but principally, into the ulnar side of the distal phalanx of the same digit.

I did not find any offset to the fourth digit, as described by Prof. Humphry[1], and represented by Cuvier in one of his figures[2] as the principal branch of the *extensor minimi digiti*.

Such an offset has, however, been found by Church in the Orang[3]; and Henle, moreover, describes[4] the tendon as sometimes splitting in Man, the two divisions either passing separately to the fourth and fifth digits, or both terminating at the latter digit, as happens, according to Meckel, in the *Ornithorhynchus*[5].

In *Hyrax Capensis* this muscle was found by Dr. Murie and Mr. Mivart dividing early into two slips, which terminated separately at the fourth and fifth digits.

In *Dasyprocta cristata*, according to the same authorities, the tendon alone was split, but its branches had a similar termination[6].

Extensor carpi ulnaris.—Starts from the external condyle of the humerus, immediately below the preceding muscle, and for the first half of its course is intimately fused with it. On reaching the distal extremity of the ulna, it becomes tendinous, the strong flat tendon lying to the ulnar side of the tuberosity mentioned in the description of the preceding muscle. Its tendon divides into two branches, one of which is inserted into the ulnar side of the base of the metacarpal of the fourth digit, the other into the inferior face of the like factor of the fifth.

The former of these branches has been well represented by Cuvier[7].

In the Anteater, according to Meckel[8], this muscle goes to the rudiments of the fourth and fifth digits.

Flexor carpi ulnaris.—This muscle may be described as made up of two factors:—a small, or deep, portion, which arises by a very distinct rounded tendon from the middle of the inner edge of the ulna; this tendon, running between the *flexor profundus* and the more superficial factor of the *flexor ulnaris*, after gradually widening, becomes muscular at about the distal fourth of the bone; and the muscle, also gradually widening, is finally inserted all along the stem of the long, style-shaped os pisiforme[9]: the bulk of the muscle arises from the whole inner edge of the ulna, and from the olecranon, by a broad aponeurotic tendon, to which the *flexor profundus* is closely adherent. Muscular fibres are not added to this aponeurosis until it attains the middle of the forearm. At its termination this factor has two distinct insertions—the outer into the free extremity of the

[1] *Loc. cit.* p. 308. [2] Pl. 254. fig. 2. [3] Nat. Hist. Rev. No. 4, Oct. 1861, p. 514.
[4] Muskellehre, p. 207. [5] Vergleich. Anat. iii^er^ Theil, p. 549.
[6] Proc. Zool. Soc. April 1865, p. 341, and June 1866, p. 405.
[7] *Op. cit.* pl. 254. fig. 2. [8] *Op. cit.* p. 540.
[9] "Le pisiforme est très-singulier, il ressemble à un stilet grêle et comprimé" (Cuvier, 'Ossemens Fossiles,' *loc. cit.* p. 135.)

pisiform bone, besides being continued on, as a strong tendon, to the palmar process of the unciform bone, while the inner, or ulnar, insertion is by tendon into the base of the proximal phalanx of the fifth digit, some fibres, too, taking origin from the tendon or ligament described above as passing from the pisiform to the unciform bone.

This muscle, according to Meckel[1], is enormously developed in the Two-toed Anteater, and is, moreover, divided into four parts. The opinion that these are all factors of one muscle (the *flexor ulnaris*) appears to be supported by the fact of their coexistence with a complete set of the muscles of the hand. Further on, however, Meckel regards one of these elements as the *palmaris longus*.

Flexor carpi radialis.—Arises from the outer edge of the external condyle of the humerus, from a tubercle immediately below that which gives origin to the *pronator teres*. It is inserted by a strong flattened tendon into the palmar aspect of the base of the metacarpal of the index, a sesamoid bone intervening at the insertion, and partly into the inferior surface of the styloid process of the radius.

The tendon of this muscle in *Dasypus sexcinctus*, as I have already described, terminates at the *trapezio-trapezoid* bone, after running through a groove in the scaphoid.

The *annular ligament* of the palm is very strong. It is attached, on one side, to the downward-looking process of the unciform bone, a flattened oval sesamoid being imbedded in it not far from this attachment, and, on the other side, into a sesamoid bone (rudiment of the pollex?) lying close to the radial edge of the trapezium.

From the anterior edge of the first-described sesamoid passes a short rounded tendon, or ligament, to the root of the branch given off to the fourth digit from the common deep *flexor* tendon.

Flexor digitorum sublimis.—With this muscle is combined, as in *Dasypus*, the *palmaris longus*, both functionally and homologically. It arises from the lowest of those factors of the deep *flexor* which take origin from the inner condyle of the humerus, at about midway between the origin and insertion of the muscle, by a tendon which runs back in the substance of this factor for some distance. At the carpo-metacarpal joint, after passing over the strong annular ligament, it becomes tendinous, and the tendon almost immediately divides into four equal-sized branches, destined one for each digit. Each of these tendons seems to be separable into two layers, the external of which, at the metacarpo-phalangeal articulation of its proper digit, is prolonged over the deeper layer, to join the projecting margin, on either side, of a large grooved sesamoid which lies at the above articulation—and is, moreover, inserted all along each side of the several phalanges belonging to its digit, so as to form a kind of sheath for the *flexor profundus*. The inner layer, which appears to answer to a "perforated tendon" (in human-anatomy language), at about the middle of the proximal phalanx of its proper digit splits to allow of the passage of the tendon of the *flexor profundus*, but joins again to run beneath the "perforating" tendon and be finally inserted at the base of the second phalanx, through the medium of a sesamoid bone.

The tendon which passed to the "middle" digit was joined, on its inferior aspect at origin, by the thin tendinous termination of a flat and delicate muscular slip which,

[1] *Op. cit.* pp. 542, 545.

passing under the annular ligament, gained its origin at the middle of the common tendon of the *flexor profundus*, at the radial side of the most internal *lumbricalis*.

The *flexor sublimis* is absent, according to Rapp, in the Tamandua, as is also a proper *palmaris longus*[1]. This author, however, describes a *tensor* ("Spannmuskel") of the *annular ligament*, which, at first sight, he says, might be taken for the latter muscle, but which passes under the *ligamentum carpi volare proprium*, as under a bridge, and is attached to the *annular ligament*. Before, however, its tendon passes under the volar ligament, it is joined by a muscle which takes origin from the olecranon and the greater part of the length of the ulna[2].

Flexor profundus digitorum.—A hugely developed muscle, having a very large and varied extent of origin. It is made up of several factors of irregular size. One of these arises from the posterior two-thirds of the inner margin of the ulna, and from its palmar aspect for a like extent, the remaining third of the inner margin of the bone being occupied by the fibres of origin of the *flexor carpi ulnaris*. The above factor, when it has run about two-thirds of its course, is joined by another, which takes origin by a strong tendon from a fossa on the inferior aspect of the humerus, situated between the external condyle and the trochlea, and which also affords origin to another slip, which joins the expanded common tendon in the middle line, lying betwixt the termination of the two principal factors of the muscle.

The greater part of the ulnar division, after being joined by a slip of inconsiderable size, which takes origin from the radius posterior to the insertion of the *pronator teres*, passes to the radial side of the expansion of the common tendon of the muscle, the ulnar side of this tendon being joined by a small remaining portion of the ulnar factor, and by that part which arises from the inner condyle of the humerus. This latter consists of two slips, which arise below the origin of the *flexor carpi radialis*, and the ulnar side of which, on completing half of its course, gives origin to the *flexor sublimis*. This condyloid factor of the muscle lies more superficial throughout its course to that portion which takes origin from the radius and ulna.

At the posterior border of the carpus all these factors join a large tendinous expansion, which has not, as in *Dasypus*, any sesamoid bone developed in its substance. This expansion, after affording origin to the *lumbricales*, divides into four equal-sized tendons, which pass as "perforating" *flexors* to the terminal phalanges of the four digits, having, moreover, at the junction of the middle with the distal phalanx of their respective digits, an indication of bifidity, but becoming single again before insertion.

The sheath of each of these tendons is, at about the middle of the proximal, and the proximal end of the middle phalanx of its proper digit, strengthened by a broad ligamentous band or arch, which passes from one side of the phalanx to the other, over the subjacent tendon. "Retinacula" also pass from the inferior surface of the "perforating" to that portion of the "perforated" tendon which, after splitting, unites again under the former tendon.

To the upper surface of the origin of the tendon destined for the fourth ("annularis")

[1] *Op. cit.* p. 48.

[2] *Op. cit.* p. 49.

digit passes a short, but strong, rounded tendon or ligament from the anterior edge of the sesamoid included in the *annular ligament*.

Neither Meckel, Rapp, nor Pouchet makes any mention of the presence of a sesamoid in the tendinous expansion of the deep *flexor* in the species of Anteater which they severally describe. Such an ossicle is present, however, in *Chlamydophorus*, as well as in *Dasypus sexcinctus*, as I have mentioned in my paper on the latter species of Armadillo.

Pronator quadratus.—This muscle, which is described as "small" by Prof. Humphry, was very well developed and of considerable extent in the specimen which I examined. It filled the whole interosseous space of the forearm, as well as the anterior face of the radius and ulna, from the level of the insertion of the *biceps* and *brachialis anticus* to the distal extremity of the two bones.

This muscle has a great resemblance to its homologue in the Great Anteater, as represented by Pouchet in his monograph (pl. iv. fig. 3), having a strong tendon running across it obliquely at the junction of its middle with its lower third. This muscle is, moreover, described by the same author as occupying three-quarters of the extent of the forearm[1].

Meckel, in his monograph upon the Two-toed Anteater, makes no mention of this muscle when describing the myology of the animal[2].

According to Rapp[3], the *pronator quadratus* is present in *M. tamandua*. Cuvier, moreover, just slightly indicates the distal extremity of the muscle in one of his plates of the myology of this animal[4], but gives no representation of it in his drawings of the anatomy of the two-toed species.

No indication of the presence of this muscle is given by the same anatomist in his plates of the Three-toed Sloth ("Aï").

I have already described this muscle as absent in *Dasypus sexcinctus*, and have, moreover, referred to Meckel's description of its peculiarities in the Aï.

Lumbricales.—Are four in number, and are well developed. One passes to the radial side of each digit, being inserted into its proximal phalanx. In the case of the index, "middle," and "fourth" digits, this attachment is effected through the medium of a tendon; but the muscle destined for the "little" finger continues fleshy up to its insertion, where, moreover, it is broader than at its origin. These muscles do not appear to have any connexion with the sheaths of the *extensor* tendons. The three outermost rise together, but quite distinct, from the expanded common tendon of the *flexor profundus*. That passing to the "little" finger rises from the same tendon, but a little more posteriorly; so that a few of its hindermost fibres of origin fuse with the terminal fibres of the enormous muscular mass which rises from the inner condyle of the humerus, and from which is given off the muscle which is the representative of the *flexor sublimis* and *palmaris longus*. Close to the radial side of the last-described *lumbricalis*, rises a thin flat slip from the tendon of the *deep flexor*, which passes under the *annular ligament* to terminate at the inferior surface of the *flexor sublimis*.

The *lumbricales* are very fairly represented by Cuvier in one of his plates[5].

Abductor minimi digiti.—A small muscle. It arises from the palmar process of the

[1] *Op. cit.* p. 17.
[2] Deutscher Archiv, V^ter^ Band (Halle und Berlin, 1819).
[3] *Op. cit.* p. 48.
[4] *Op. cit.* pl. 263. fig. 2.
[5] *Op. cit.* pl. 256. fig. 5.

unciform bone, and is inserted, a sesamoid ossicle intervening, into the base of the proximal phalanx of the "little" digit. Some fibres, too, join the tendon of the innermost of the superficial *interossei*.

Interossei.—These muscles, to avoid confusion as much as possible, are, I think, better divided into *superficial* and *deep*, than into *palmar* and *dorsal interossei*. There are only two superficial muscles, which cross each other like the upper arms of an X and seem to correspond to two out of the three muscles described by Prof. Humphry as "*palmar*" *interossei*[1].

The one which passes to the "little" digit arises from the ulnar half of the palmar ligament, immediately anterior to the front margin of the unciform bone. It is a fan-shaped muscle; and its fibres radiate towards a flat tendon, which, passing along the radial side of the little digit, joins that branch of the *extensor communis* which is sent to this digit. On becoming tendinous it is joined by a slender offset from the *abductor minimi digiti*.

The other superficial *interosseus* is covered by, and arises a little in advance of, the preceding, from the palmar ligament at the neighbouring parts of the bases of the metacarpals of the third and fourth digits. After widening a little from its origin, it again gradually contracts, and joins, through the medium of its tendon, the tendon of the deep *interosseus* which passes to the ulnar side of the index.

When these two muscles act in concert, they must strongly adduct the outermost and innermost digits towards the middle line of the hand.

Deep *interossei*.—To facilitate description, it had better first be stated that each digit has a strong ligament, oblique in direction, attached, at one extremity, to the ulnar side of the base of its metacarpal, at the other, after previously forking, into the sesamoid at the base of its proximal phalanx. The deep *interossei* have great extent of origin from these ligaments, which may conveniently be termed "metacarpal" ligaments, and from each of which a pair of the above muscles arises, those taking origin from the radial sides passing to the radial, those from the ulnar passing to the ulnar sides of their corresponding digits.

The radial *interosseus* of the index has two heads of origin—one, fusiform, by a distinct tendon, from the anterior edge, palmad, of the scaphoid, the other from the radial side of the metacarpal ligament of the index. These, after junction, become tendinous; and their tendon joins the branch of the *extensor communis* sent to the index. The ulnar *interosseus* of this digit arises from the inner side of its metacarpal ligament, and, after becoming tendinous, sends an offset to the sesamoid bone, is joined by the radial of the two superficial *interossei*, and passes to the expansion of the common *extensor* tendon over the proximal phalanx. This muscle may, I think, be termed conveniently, if not homologically, "abductor indicis." The "middle" and "fourth" digits have each a deep *interosseus* on either side. From the obliquity of the metacarpal ligaments of the index and two succeeding digits, the muscles on the radial sides seem to have a much more strictly *palmar* origin than their fellows on the ulnar sides—these latter being almost hidden, when the digits are closely approximated, in the intermetacarpal spaces.

[1] *Loc. cit.* p. 305.

The radial and ulnar *interossei* of the "middle" and "fourth" digits, after taking origin from the corresponding sides of the ligaments of their respective metacarpals, sent each an offset to the sesamoid at the base of the proximal phalanx of its proper digit, and finally joined the *extensor* tendon above. The radial *interosseus*, however, of the "middle" digit had two heads of origin, one from the ulnar side of the metacarpal ligament of the index, the other from the radial side of the ligament of its proper metacarpal.

Each digit, it will be seen, has an interosseous abductor and adductor, the index possessing, moreover, an accessory adductor on its ulnar side.

Lower Extremity. *Gluteus maximus.*—A very broad and flat muscle, but of no great thickness. It took origin from the crest of the ilium, and from what, for want of a better term, I must call the "sacral aponeurosis." Its lowest fibres of origin are overlapped by the superior edge of the strongly developed *biceps*; which fact may have led Prof. Humphry to describe the *gluteus* as continued down to the heel[1], while in reality it is the *biceps* which undergoes so considerable an extension, a point which Cuvier has very clearly and correctly indicated in one of his plates[2].

The only actual point of *insertion* of the muscle is the strongly developed third trochanter of the femur, to which the *gluteus* is attached by a flat tendon, developed early along its inferior edge. The anterior portion of the muscle, moreover, is lost in fascia, in which the *tensor fasciæ* terminates, and which is also continuous with the tendon of the *biceps*.

Tensor fasciæ femoris.—Is a distinct muscle[3], which may be, however, but a differentiated layer of the preceding. It takes origin from the homologue of the anterior superior spine of the ilium, being almost completely overlapped by the anterior portion of the *gluteus maximus*, and is continued into the fascia in which part of the preceding muscle is lost, and with which the tendon of the *biceps* communicates, and which is also attached to the outer side of the femur from the third trochanter to the condyle. Prof. Humphry evidently regards this muscle as but a differentiated portion of the *gluteus*.

The editor of the second edition of Cuvier's 'Leçons,' in the following parenthetical remark, may possibly be alluding to the *tensor fasciæ*[4]:—"Dans tous les mammifères, le *fascia lata* a un muscle assez fort qui se sépare difficilement du grand fessier."

Gluteus medius.—A well-developed muscle, taking origin from the outer face of the ilium and adjoining portion of the sacrum. The greater part is inserted into the outer and inferior aspect of the great trochanter, covering the terminal portions of the *gluteus minimus* and *pyriformis*, the rounded anterior edge becoming intimately connected with that of the former of these two muscles; while a thin factor, which is rolled over its posterior edge, is inserted along the outer and inferior edge of the femur, nearly as far as the third trochanter.

Cuvier gives, in one of his plates[5], a very good representation of the two portions of the *gluteus medius*.

[1] *Loc. cit.* p. 311.
[2] *Op. cit.* pl. 254. fig. 2.
[3] Cuvier, pl. 256. fig. 1.
[4] Vol. i. p. 521.
[5] Pl. 256. fig. 1, *op. cit.*

Gluteus minimus.—Arises from the outer surface of the ilium, covered by the upper two-thirds of the *pyriformis*, and is inserted above this muscle into the upper part of the great trochanter.

Pyriformis.—A large well-developed muscle, taking origin mostly from the outer face of the ilium near its junction with the sacrum, a few of its lowermost fibres arising from the inner face of the latter bone. It is inserted by a broad strong tendon into the outer face of the external trochanter, below the termination of the *gluteus minimus*. For the whole of its extent, both at origin and at insertion, it is covered by the *gluteus medius*.

Perhaps this muscle ought to be regarded as a deeper factor of the *gluteus* last mentioned. A fair representation of it may be found in Cuvier's plates[1].

Obturator externus.—Is a large, fleshy, fan-shaped muscle, taking origin from the anterior half of the circumference of the obturator foramen, and being inserted by a strong tendon into the digital fossa of the femur.

Obturator internus.—This muscle, which I have described as absent in *Dasypus sexcinctus*, is, for a great part of its extent, concealed within the pelvis; but its terminal portion may be seen emerging at the lesser sciatic notch, immediately below the representation of the lesser sacro-sciatic ligament, at which point it passes over a smooth-grooved facet and becomes tendinous, its tendon very soon fusing with that of the *gemelli*.

According to Cuvier[2] the *obturator internus* arises solely from the inner aspect of the posterior branch of the ischial tuberosity.

Gemelli.—Are very well developed, and occupy their usual position in relation to the preceding muscle. They seem, however, each to have two heads of origin. The superior *gemellus* rises, as usual, from the posterior edge of the ischium, immediately above its "spine"—also, for a certain extent, from the inner face of the bone. It is, moreover, reinforced by a flat muscular slip which takes origin from the posterior half of the sacral edge of the large sacro-ischiatic foramen, and the tendon of which joins the first-described element of the muscle after this has become tendinous. The inferior *gemellus* takes origin, in part, from the free edge of the ischium below the spine of the bone, but mostly, as a large fleshy belly, from the posterior part of the tuberosity and from what may be regarded as the greater sacro-sciatic ligament.

The strong conjoined tendon of the *gemelli* is joined in the middle by that of the *obturator internus*, and then terminates in the digital fossa, above the insertion of the *obturator externus*.

Prof. Humphry does not appear to have found any sacral origin of these muscles in the specimen which he has described[3]; but Cuvier has left a short note, which M. Ad. Focillon has incorporated in a description of his plates of the *Orycteropus*, and which is as follows:—"Les Jumeaux viennent du Sacrum; le Jumeau postérieur (inférieur) a aussi des fibres de la tubérosité de l'Ischion."

Quadratus femoris.—My specimen agreed with that of Prof. Humphry in not possessing the above muscle. Cuvier, however, has in two of his figures[4] attached to a large muscle

[1] Pl. 256. fig. 3, *op. cit.*

[2] See short note by this author, appended to the description of his plates of the anatomy of *Orycteropus*.

[3] *Loc. cit.* p. 312.

[4] *Op. cit.* pl. 256. figs. 1 & 3.

the symbol proper to the "carré de la cuisse"; but I think that the muscle here represented must be that which I have regarded as the homologue of the "adductor minimus" of Henle, and which Cuvier has figured elsewhere[1] as the "moyen adducteur."

According to Meckel[2], the *quadratus femoris* is absent in the Anteater.

Theile[3] notices the occasional absence of this muscle in Man, and further observes that "alors les jumeaux ont plus de volume." With the only instance in which Hallet found the *quadratus femoris* deficient in Man (out of 105 subjects examined), there was associated an unusual development of the two *gemelli* and *obturator internus*[4].

On reference being made to my paper on *Dasypus sexcinctus*, it will be seen that while the muscle in question is in this animal exceedingly well developed, the *obturator internus* is absent, and the *gemelli* very small—the converse of Theile's and Hallet's observations being thus illustrated in a very singular manner.

Such mutual compensation, however, is by no means always to be found in animals; for in the *Echidna*, according to Mr. Mivart[5], the *quadratus femoris* is a "delicate muscle," though both *obturator internus* and *gemelli* are completely absent.

Ilio-psoas.—The origin of this compound muscle could not with certainty be determined, since much damage had been done to it in the evisceration, as I suppose, of the animal. It is inserted along the inner trochanter of the femur as high up as the head of the bone, and along the inner edge of its shaft for nearly the extent of its upper half.

Cuvier represents[6] the *iliacus* muscle as being in two portions near its insertion. Prof. Humphry, however, makes no mention of any such division. The condition of this portion of the animal which I examined did not allow any verification of this point.

The former author, too, represents[7] the *psoas* as having the lowest insertion along the femur. Now, as far as I could determine, this muscle is inserted tendinously into the trochanter alone, while the *iliacus* is continued fleshy along the inner edge of the shaft of the bone.

Psoas parvus[8].—For a like reason to that already given in the case of the preceding

[1] *Tab. cit.* fig. 4. [2] *Op. cit.* p. 586. [3] Encyclopédie Anatomique (Paris, 1843), vol. iii. p. 279.
[4] Edin. Med. and Surg. Journ. vol. lxix. 1848, p. 20. [5] Trans. Linn. Soc. 1866, vol. xxv. p. 392.
[6] *Op. cit.* pl. 255. [7] *Op. cit.* pl. 256. fig. 4.
[8] It is much to be regretted that the bulk of this muscle had not been preserved in the specimen from which my notes are derived; for its condition of development might serve to throw some light upon the probability or otherwise of the *Orycteropus* frequently assuming a Kangaroo-like attitude. See Rapp, *op. cit.* Taf. i., where one of the animals figured is represented in the erect position—the strong stout tail forming the third element of its tripodal support, and the hand drooping from the forearm in a position frequently to be witnessed in *Macropus* as a natural condition, and in *Homo* as a pathological one. Such an attitude must, I think, be greatly subserved by the muscle in question, seeing that its homologue in the Kangaroo, according to Meckel (Vergleich. Anat. p. 590), exceeds in bulk the *psoas magnus* by at least ten times. Prof. Humphry merely remarks that it is "large," but makes no observation as to its size in relation to that of the "great" *psoas*.

I have found no record, in the works which I have consulted on the subject, of the Aard-vark being known to assume the attitude in which it has been represented by Rapp.

The figure above mentioned may, after all, be but the representation in the concrete of an abstract conception formed by its author of the possible existence of marsupial affinities in the *Orycteropus*.

Since the above was written, I have seen, among the stuffed specimens of Bruta preserved in the British Museum, an Anteater, labelled "*Tamandua tetradactla*" (*sic*), which was placed erect upon its hind legs, the tail being curled

muscle, the origin of this muscle could not be determined with any accuracy. It was inserted by a rounded tendon into the strongly developed ilio-pectineal tubercle[1].

Pectineus.—This muscle appears to be made up of two distinct portions, which seem to answer to the two layers into which its homologue in Man may, according to Henle[2], be differentiated. Cuvier, too[3], distinctly represents a like arrangement in the animal which is the subject of this description.

The first or upper portion of the muscle is strap-shaped, and takes origin from the strong ilio-pectineal tubercle, beneath that of the *gracilis*. It is inserted into the "linea aspera" of the femur, from below the lowest point of insertion of the *iliacus* to the femoral insertion of the *semimembranosus*. The second or lower portion is much smaller, and arises from the ilio-pectineal line, between the origin of the first factor of the muscle and that of the *adductor longus*. It is inserted into the lowest portion of the posterior intertrochanteric line, on the border of the digital fossa.

The arrangement of this muscle in Prof. Humphry's specimen appears to have been very different[4].

Adductors.—These "adductors" proper appear to be present. They seem to answer respectively to the *longus* and *brevis* of human-anatomy nomenclature, and to the muscle termed by Henle[5] "minimus,"—the upper portion of the great adductor, according to Theile and other anatomists.

α. The homologue of the *adductor longus* is a muscle of comparatively small size; it springs from the lower portion of the ilio-pectineal line and from the spine of the pubes, just below or posterior to the second or inferior division of the *pectineus*, being overlapped by the highest fibres of origin of the *gracilis*. It passes, uniform in breadth, to be inserted by a thin tendon into the linea aspera of the femur, alongside of the inserted portion of the first division of the *pectineus*. I could not find any special or distinct representation of this muscle in Cuvier's plates.

β. This muscle, which I am inclined to regard as homologous with the *adductor brevis*, is of very great size, and has an extensive origin from the remaining portion of the pubes included between the symphysis and lowest fibres of origin of the *adductor longus*, also from the greater part of the descending ramus of this bone, being covered partly by the *gracilis*, and partly by the *semimembranosus*. It has a lower point of insertion than any of its fellows, since it terminates on the inferior surface of the femur, diagonally between the third trochanter and a point midway between the origins of the *gastrocnemii*.

Cuvier gives a fair representation of this muscle, divided close to its origin and insertion[6], but letters it as the *adductor brevis*.

γ. The remaining muscle answers, I think, most nearly to that portion of the "great" adductor termed and figured[7] by Henle "*adductor minimus*." Cuvier, in the figures cited

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round on the board which supported the specimen. The upper half of the body was bent forward at nearly a right angle with the lower part, while the fore limbs were disposed as they are in a Kangaroo.

[1] "Une apophyse pointue sur la base du pubis, et dirigée en avant, c'est-à-dire, vers le ventre." (Cuvier, 'Ossemens Fossiles,' *loc. cit.* p. 136.) [2] Muskellehre, p. 268, and fig. 139. [3] Anat. Comp. pl. 256. fig. 4.
[4] *Loc. cit.* p. 310. [5] *Op. cit.* p. 270. [6] *Op. cit.* pl. 256. figs. 4 and 6. [7] *Loc. cit.* fig. 140.

above, letters this muscle as the "moyen adducteur" (the "adductor longus" of the modern English schools).

This adductor has a large fleshy origin from the ascending ramus of the ischium and from part of the triangular surface included between the obturator foramen and the tuberosity, being overlapped by the adductor muscle last described, and covered for the rest of its extent by the *semimembranosus*, *tendinosus*, and *biceps*. Narrowing gradually towards its termination, it is inserted, partly fleshy, partly tendinous, into a sharp-pointed tubercle situated on the ridge which runs down from the lesser trochanter, along the inferior surface of the femur, just superior to the combined insertions of the *adductor longus* and the first division of the *pectineus*.

The muscle which I have termed *adductor longus* may, after all, be only a third element of the *pectineus*.

Cuvier, although he has represented two *adductors* in his plates, has nevertheless left on record the following note, which M. Focillon has appended to his description of these plates,—"Il n'y a qu'un adducteur."

The Aï has, according to Meckel[1], four *adductors*, besides a *pectineus* of very great extent of insertion. The Anteater, also, has a large *pectineus*, but only a single *adductor*, which, however, is well developed, and formed from three heads.

Quadriceps extensor.—The *rectus femoris* has no peculiarities worthy of much notice. It was well developed, and took origin from the superior and posterior margins of the acetabulum, and was inserted into the superior edge of the patella in company with the *vastus* of either side.

The *vastus externus* was enormously developed. It arises from the external aspect of the femur and from the whole of its anterior surface, from as high a position as the space included between the great trochanter and the head of the bone. It is inserted into the outer edge of the patella, overlapping the *rectus* at its insertion.

The *vastus internus* is much smaller, but is so fused with the preceding muscle in the middle line, that a boundary can hardly be sharply marked between them. It arises from the inner edge of the upper half of the femur immediately below the head of the bone, and is inserted, having previously fused with the *rectus*, into the inner edge of the patella. The aponeurotic termination of the *sartorius* is intimately adherent to its upper surface.

No *crureus* can be differentiated from the muscle, unless the lowermost layer of the *vastus externus*, which arises from the anterior aspect of the femur, be reckoned as this muscle.

The patella, besides being connected with the smooth broadened-out origin of the spine of the tibia by a strong "ligamentum patellæ," is fastened to the femur by a kind of side stay, in the shape of a strong flat ligament which passes from its inferior edge to the outer aspect of the external condyle.

Sartorius.—Appears to have slipped down from its usual origin, since it arises from the strongly developed ilio-pectineal tubercle, immediately above the highest fibres of origin of the *gracilis*. It then passes forwards, and ends in the upper portion of the

[1] *Op. cit.* p. 596.

terminal aponeurosis of the *gracilis*, besides becoming continuous with the dense fascia covering the *rectus* near its insertion. The *sartorius* is separated from the subjacent muscles by fascia, in which the internal saphenous vein runs upwards towards its termination.

Cuvier gives in his plates a very distinct representation of this muscle, which agrees with my description[1]. According to Prof. Humphry[2], however, this muscle has no connexion with the ilium, but arises from the hindmost ribs.

The editor of the second edition of Cuvier's 'Leçons' (*loc. cit.* p. 518) confirms Meckel's statement (*loc. cit.* p. 614), that this muscle in the Aï has a *femoral* insertion; but states that it comes from the ilium, and not, as the latter anatomist has said, from the aponeurosis of the *external oblique*.

Semitendinosus.—This muscle consists of two quite distinct portions, both as regards their origin, course, and insertion. The first portion, which corresponds to the muscle of the same name in Man, is of uniform breadth, strap-shaped, and takes origin from the whole extent of the free edge of the tuberosity of the ischium, including the spine at its most posterior boundary. It passes across the thigh to be inserted into the inner layer of the aponeurotic termination of the *gracilis*, being covered by the lowest portion of this muscle at its insertion. When it reaches the posterior border of the *gastrocnemius*, the muscle receives on its inferior edge a contribution from the *semimembranosus*, which becomes continuous with fascia or aponeurosis extending to the calcaneum.

The second portion of the muscle, also uniformly broad and strap-shaped, arises immediately below the origin of the *gluteus medius*, from a small portion of the free edge of the sacrum, just below its juction with the ilium, also from the dense fascia covering the *erector spinæ*. It then passes over its fellow at its origin, and finally fuses with the broad flat tendon of the *gastrocnemius* just at the junction of its two heads.

Cuvier distinctly represents these two divisions of the muscles in his plates, and designates the last-described factor as the "Accessoire bicipital du demi-nerveux"[3].

This latter portion of the muscle does not appear to have been present in the specimen described by Prof. Humphry. The editor of the second edition of Cuvier's 'Leçons' states in a footnote[4], concerning this muscle and the *semimembranosus*, that they, and sometimes only the latter, receive an accessory coccygeal portion. This arrangement, he says, is found principally in Rodents and in the Edentata.

Semimembranosus.—An enormously developed muscle, which arises from the whole extent of the tuberosity of the ischium, and from part of the ascending ramus of the bone, also, for some distance, from the side of the strong fascia covering the caudal muscles.

It passes upwards, its most posterior fibres of origin being fused for some distance with the *biceps*, to be inserted mainly into the deep layer of the aponeurosis common to it and the *gracilis* and *sartorius*; while a small portion, derived from the superior edge of the muscle, finds insertion into the edge of the femur, a little above the inner condyle, close to the origin of the inner head of the *gastrocnemius*.

[1] *Op. cit.* pl. 255, and 256. fig. 4.
[2] *Op. cit.* pl. 255, and 256. figs. 1 and 3.
[3] *Loc. cit.* p. 311.
[4] *Loc. cit.* p. 522.

Those fibres which are fused at origin with the *biceps* eventually join the inferior edge of the inner portion of the *semitendinosus* just before its insertion.

Biceps.—A large muscle, arising immediately below the *gluteus maximus*, seemingly from fascia covering the dorsal muscles, and fusing at the lowest part with the *semimembranosus*. Its upper portion speedily becomes differentiated from the rest of the muscle, and has a tendon developed along its inferior edge, which is finally inserted into a tubercle at the head of the fibula, near its junction with the tibia, being continuous, by its upper edge, with the aponeurosis or fascia in which the *tensor vaginæ femoris* is lost.

The rest of the muscle covers the whole of the triangular space included between a basal line drawn from its origin to its insertion and a popliteal apex formed by the semiflexed leg with the thigh, and terminates partly in fascia covering the front of the leg, and partly at the calcaneum, the muscular fibres being continued almost down to this bone.

Prof. Humphry[1] notices only the latter mode of termination. Cuvier's representations of this muscle[2] agree very well with my descriptions. The editor, moreover, of his 'Leçons' states[3] that in the Orycteropus, as well as in the Armadillo, the *biceps* descends to the calcaneum.

In this animal, as in *Dasypus*, the *biceps* has no femoral head of origin. In the Aï and Anteater, on the contrary, according to Meckel[4], this muscle derives part of its origin from the femur.

Gastrocnemius.—A muscle of great development. Its external head takes origin from the outer margin of the femur, immediately above the condyle, mainly by a strong tendon, in which a sesamoid bone, or "fabella"[5], is developed, which plays over a smooth facet on the posterior part of the condyle. The inner head arises by a strong tendon from the inner edge of the shaft of the femur, immediately above the condyle of the same side, and fleshy from the internal lateral ligament. It joins with its fellow a little below the middle of the calf, to terminate eventually at the posterior extremity of the calcaneum, in a strong "tendo Achillis." A small slip is given off from the outer factor, to be inserted close to, and in advance of, the *soleus*.

The possession of a sesamoid bone in the origin of the *gastrocnemius* is by no means peculiar to the Orycteropus, as will be shown by the following instances.

Meckel describes, in his monograph on the two-toed Anteater[6], a bone of this description as lying at the hinder aspect of the outer condyle of the femur, which, evidently, as in *Orycteropus*, belongs to the *gastrocnemius*, though not mentioned by him in connexion with this or any other muscle.

[1] *Loc. cit.* p. 312.

[2] *Op. cit.* pl. 254. fig. 2, and 256. figs. 1 and 3.

[3] *Loc. cit.* p. 521.

[4] *Op. cit.* pp. 607–8.

[5] "There is a fabella behind the outer condyle of the femur."—Prof. Owen 'On the Anatomy of Vertebrates,' vol. ii. p. 409; Ost. Catal. Coll. Surg. vol. ii. p. 422. Cuvier neither figures nor mentions this bone in his 'Ossemens Fossiles.'

[6] Deutsche Archiv für die Physiologie, J. F. Meckel, funfter Band (Halle und Berlin, 1819). p. 28.

Douglas[1] mentions the origins of the heads of the *gastrocnemius* in the dog "from the two ossa sesamoidea that adhere to the two condyles of the femur."

Krause, in his monograph on the Rabbit[2], does not refer to any sesamoid in connexion with the *gastrocnemius*, but states that the *plantaris* arises from such a bone in the neighbourhood of the "lateral condyle" of the femur.

In Meckel's 'Comparative Anatomy'[3] a long list is given of animals which have one or more of these bones in the *gastrocnemius*. On his authority, they occur in both tendons in many Apes, in the Mole, in the Agouti, Porcupine, and other Rodents. In *Stenops*, however, among Quadrumana, and, among Edentata, in the Aï and the Anteater, there is but one sesamoid; but in the latter Order they are larger than in other mammals. They are wanting in the *Ornithorhynchus*, among Monotremes, and in Man they are seldom present.

Dr. Ilg, in his monograph on sesamoid bones[4], mentions the existence of bones of this character in the origins of the *gastrocnemius* in *Cynocephalus sphinx* (*Simia sphinx*, Linn.). Meckel[5] has noted the same in his 'Comparative Anatomy' as occurring in this species of Ape.

Burdach[6], in a paper upon the myology of *Innus*, *Cynocephalus*, and *Cercopithecus* (species not given), mentions the existence of such a bone at the outer as well as the inner condyle of the femur, in the origins of the *gastrocnemius* in these Apes.

Man is not exempt from the presence of such bones in the *gastrocnemius*; for, according to Sœmmering[7], "non raro tendo ventris externi os sesamoides excipit." The same anatomist remarks, after citing an author who had found two bones of this description, "forsan vero alterum fuit ossiculum, quod passim in bursis mucosis invenitur."

Henle, too, mentions the occasional occurrence of sesamoid bones in Man[8], in the lateral and, more rarely, in the middle head (*soleus*) of the *gastrocnemius*, but regards them as pathological ossifications, such as are caused in other muscles by friction, *e. g.* in the median portion of the *vastus* in riders—a point which Fordham or Custance may some day have the privilege of illustrating.

In the fine skeleton of the *Megatherium*, preserved in the Museum of the Royal College of Surgeons, there is a sesamoid bone behind the outer condyle of the left femur. In all probability this was once imbedded in the *gastrocnemius* of this huge species of Sloth.

Soleus.—A flat and comparatively broad muscle, taking origin by a distinct tendon, imbedded in the origin of the deep flexor, from a sharp tubercle on the posterior aspect of the head of the fibula, and being inserted into the superior and inner face of the calcaneum.

Prof. Humphry makes no mention of this muscle by name. He may, however, with the old anatomists, have described it as an element of the *gastrocnemius*, in which case it will answer to his description of the third head of origin of this latter muscle[9].

[1] Myographiæ Comparatæ Specimen (London, 1707), p. 154.
[2] Die Anatomie des Kaninchens (Leipzig, 1868), p. 121.
[3] *Loc. cit.* p. 634.
[4] Monographie der Sehnenrollen, zweiter Abschnitt, erste Abtheilung (Prag, 1824), p. 35.
[5] *Loc. cit.* p. 634.
[6] Beitrag zur vergleichenden Anatomie des Affen (Königsberg, 1838), p. 47.
[7] De Corp. Hum. Fabr. (Trajecti ad Mœnum, 1796), tome iii. p. 306.
[8] Muskellehre, p. 288.
[9] *Loc. cit.* p. 313.

Meckel describes the *soleus* under the name of the "deep head" of the *gastrocnemius*, as being in the Edentata, at all events in the Aï and the Anteater, larger than the more superficial head of this muscle[1]. Further on he gives a special description of its arrangement in these animals, under the specific name of "Sohlenmuskel."

Plantaris.—This muscle, which Prof. Humphry has included in his description of the *gastrocnemius*, arises by a strong tendon slightly posterior to, and to the inner side of, the external head of the latter, and, after running down between the above muscle and the *soleus*, lies tendinous to the inner side of the tendo Achillis, just above the calcaneum, but, passing over this tendon at the posterior and inferior part of the bone, joins finally the plantar fascia. An offset, however, is distributed to each digit, which had the arrangement of the *flexor sublimis* in the upper extremity, the superficial layer forming a sheath for the deep or "perforating" flexor, the deeper layer being a "perforated" tendon, except in the case of the hallux.

The tendon of this muscle, though it does not terminate at the os calcis, has a strong attachment to a rough ridge which runs down along the inner side of this bone from the insertion of the soleus.

In the Aï, according to Meckel[2], this muscle is well developed, and is fused with the "perforating" flexor.

Rapp describes the *plantaris* as absent in *M. tamandua*[3].

Popliteus.—Is a well-developed muscle. It arises from a depression in the outer aspect of the external condyle by a strong flat tendon, covered by the origins of the *peronei*, and is inserted all along the posterior part of the tibia, from the head of this bone to its malleolus.

Flexor longus digitorum.—Arises from the posterior part of the fibula, completely covering in the most posterior of the *peronei* muscles, besides taking origin in part from the strong external lateral ligament, also from the interosseous membrane and inner edge of the tibia. At the heel it becomes tendinous; and the strong flat tendon, after running along the inner side of the calcaneal process, passes under a strong ligamentous bridge, stretched between the astragalus and plantar fascia, and, at about the middle of the sole, expands, soon to split into five "perforating" tendons, destined one for each digit, the hallux included.

Immediately before the tendon broadens out, as described above, there is given off from its fibular side, to join the peroneal tubercle of the calcaneum, a strong flat ligamentous or tendinous band. This is regarded by Prof. Humphry[4] as the representative of the *flexor accessorius*, and is figured as such by Cuvier[5].

As far as can be made out by the naked eye, there is no trace of muscular tissue in this rudimentary representative of the accessory *flexor*.

The "perforating" tendons terminate in their respective digits in the same manner as do those of the deep flexor in the fore foot, and complete their resemblance by presenting an indication of bifidity just before insertion.

The attempt at a differentiation of a *flexor longus hallucis* from the substance of the

[1] Vergleich. Anat. p. 630 *et seq.*
[2] *Loc. cit.* p. 656.
[3] *Op. cit.* p. 50.
[4] *Loc. cit.* p. 317.
[5] Anat. Comp. pl. 256. fig. 6.

common flexor of the toes will be noticed under my description of the *tibialis posticus*.

Rapp describes, under the old name of "caro quadrata Sylvii," an accessory flexor as present in *Myrmecophaga tamandua*[1]. According to the same authority, the hallux in this animal has no special flexor, but shares with the other digits the tendinous supply of the common flexor.

Flexor brevis digitorum.—This muscle, as in the case of *Dasypus*, was absent.

Meckel observes[2] that it appears most correct to admit that the Edentata are deprived of a small *flexor communis*, and that that which is described as such represents the short head of the perforating *flexor*, for the reason that the tendons of the former are not perforated, and that the analogy with the anterior member militates in favour of this conclusion.

Tibialis posticus.—This muscle took origin from the inner aspect of the head of the fibula, and from the opposite-looking edge of the posterior portion of the tibia, and in part from the interosseous membrane, the anterior tibial vessels passing between its fibular and tibial heads of origin. It is intimately connected, for nearly the whole of its length in the calf, with the *flexor digitorum*. A little above the inner malleolus it is continued into two flat tendons, which pass under a strong ligamentous pulley or arch, situated on the posterior aspect of the above process.

The deeper of the two tendons, after passing under a strong internal lateral ligament of the ankle, which separates it from its fellow, terminates at the posterior part of the inferior ridge of the ento-cuneiform bone ("hinder part of scaphoid," according to Prof. Humphry[3]); while the more superficial, belonging to the fibular belly of the muscle, divides into two branches, one of which joins by a broad expansion the tendon of the common *flexor*, while the other terminates at the posterior part of the sesamoid ossicle[4] which lies alongside of the ento-cuneiform bone, and which is attached, by a ligament proceeding from its anterior extremity, to the inner side of the base of the proximal phalanx of the hallux.

Cuvier's representation of the termination of the last-named tendon is very clear[5].

The broad expansion of the first-mentioned branch of the superficial tendon had connexions which are of interest, since they tend to show a differentiation, in an animal belonging to the Bruta, of a *flexor longus hallucis* from the *common flexor* muscle; for, posteriorly, it was continued tendinous into a muscular offset from a portion of the *common flexor* which arose from the lower part of the fibula, while, anteriorly, it took a large, nay, almost a principal share in forming the flexor tendon of the hallux.

An arrangement somewhat similar to that just described is occasionally met with in Man, according to Bichat[6], in the tendon of the *tibialis posticus*, of which, besides its usual prolongation to the ento-cuneiform bone, "souvent autre prolongement, qui est externe, se poste sous la plante du pied, et se confond avec ses ligamens."

[1] *Op. cit.* p. 50. [2] *Op. cit.* p. 657. [3] *Op. cit.* p. 315.

[4] No mention whatever is made of this ossicle (which exists in *Dasypus* proportionally better developed) by Prof. Humphry. According to Cuvier, 'Ossemens Fossiles,' *loc. cit.* p. 136, "l'os surnuméraire du bord interne [of the entocuneiform], s'il existe, est fort petit."

[5] Anat. Comp. pl. 256. fig. 6.

[6] Traité d'Anatomie Descriptive (Paris, 1802), tome ii. p. 324.

The muscles which arise from the extensor surface of the leg in *Orycteropus* are well marked off into three distinct groups, each of which passes under a strong ligamentous pulley peculiar to it.

The tibial group comprises muscles proper to the hallux; such are the *extensor proprius* of this digit, and the *tibialis anticus*.

The middle group includes but the four tendinous offsets of the *extensor communis*, while under the group on the fibular side are comprised the *peroneal* muscles.

Peronei.—These muscles are so blended together at origin that it is not easy to isolate them for description. They arise along the outer edge of the fibula, in close company with the *extensor communis*, from the inward-looking aspect of the head of the bone, and from the external lateral ligament and outer semilunar cartilage.

Just above the outer malleolus, they become tendinous; and their tendons, four in number, are kept in place behind this strongly projecting process by a ligamentous band or pulley.

The most anterior at origin passed over the *extensor brevis digitorum* to join the expansion of the common *extensor*, at the base of the proximal phalanx of the fourth digit, sending off also a slight slip to terminate in like manner at the little toe.

A second passed to the outer side of the base of the proximal phalanx of the fifth digit, joining here the metatarso-phalangeal expansion of the *common extensor* tendon.

Another terminated at a very strong tubercle developed on the outer side of the base of the metatarsal bone of the same digit.

The two last-described muscles seem to answer tolerably fairly to the *peronei tertius* and *brevis* of human anatomy, respectively.

The first muscle seems to answer very fairly to one described by Mr. Mivart and Dr. Murie, in their paper on the "Anatomy of the Crested Agouti"[1], as the *peroneus quarti digiti*; or it may be regarded as the muscular resultant developed by the fusion of this with the *peroneus quinti digiti*.

The tendon of the homologue of the *peroneus longus* passed over a groove in a tubercle situated on the outer side of the head of the os calcis, and, on gaining the sole, took a turn at a right angle, and passed under the strong plantar ligaments to its usual insertion at the fibular side of the base of the metatarsal of the hallux. Soon after its entrance into the sole, it detached, as described by Prof. Humphry[2], an offset from its anterior edge, which was inserted into the tibial side of the metacarpal of the fifth digit. Record of a similar arrangement will be found in my paper on the myology of *Dasypus*. No reference to this important point has been given, as far as I am aware, either by Meckel or by Cuvier.

Such a disposition of the tendon of the *peroneus longus* as that just described obviously ensures the simultaneous adduction, towards the middle line of the foot, of the hallux and fifth digit.

Tibialis anticus.—A strong, well-developed muscle, arising from the arch formed by the junction of the tibia and fibula at their upper part—also by a small slip from the anterior ridge of the former bone, just below the insertion of the patellar ligament—in

[1] Proc. Zool. Soc. June 1866.

[2] *Loc. cit.* p. 319.

part, too, from the outer edge and a small part of the anterior face of this ligament, and from the tendon of the *biceps*. At the inferior extremity of the tibia the muscle suddenly contracts, and passes tendinous under a very strong ligamentous pulley which is shared by the *extensor hallucis*. Two tendons are developed from this muscle, one of which passes to the inner side of the base of the metatarsal of the hallux; while the other, after coursing down the side of the foot behind the former tendon, is inserted into the anterior part of the inferior edge of the ento-cuneiform bone, and has also a slight communication with the base of the metatarsal.

This muscle, as I have described, possesses but one terminal tendon in *Dasypus*.

In the Aï and Anteater, according to Meckel[1], the *tibialis anticus* has two heads of origin, which, however, meet in a common tendon which is inserted into the rudiment of the hallux. Meckel hints that the external of these two factors may represent the extensor of the hallux.

Dr. Ilg[2] describes in *Cynocephalus sphinx* a differentiated slip from this muscle, which he terms "abductor hallucis longus," and states to be absent in man. It was fused at origin with the *tibialis anticus*, and was inserted into the plantar aspect posteriorly of the metatarsal of the hallux.

This muscle, according to Burdach[3], has two terminal tendons in *Cercopithecus*; but in *Inuus* and *Cynocephalus* one of these belongs to a differentiated muscular slip. He holds that in each case the supernumerary muscle or tendon must be regarded as an *abductor longus hallucis*.

The description of the *tibialis anticus* in *Nycticebus tardigradus* is thus concluded by Mr. Mivart and Dr. Murie:—"There is no trace whatever of any division of the tendon of this muscle, *à fortiori* not of its muscular part"[4].

Church describes, in the Orang, a splitting into two parts of the tendon of this muscle, as well as of that of its serial homologue in the hand, the *extensor ossis metacarpi pollicis*[5].

Prof. Huxley, in his lectures on the Mammalia at the Royal College of Surgeons, remarked that the division of the tendon of the *tibialis anticus* was, in the Chimpanzee, carried up into its muscular fibres, in some cases quite to their origin, so that the anterior portion had been described by Cuvier and others as a distinct muscle—the *abductor hallucis longus*. The tendon of the *extensor ossis metacarpi pollicis* is also in this Ape, according to Prof. Huxley, double. In the same course of lectures, the terminal tendons of both of these serially homologous muscles were described as double in the Gorilla, in the Orang, and in *Hylobates*. This differentiation of the tendon did not, however, extend to the muscle itself[6].

Sœmmering describes, in his work upon Human Anatomy[7], a division of the tendon of the *tibialis anticus* before insertion, the larger portion terminating at the cuneiform bone, the smaller at the metatarsal of the hallux.

According to Henle, the tendon of the *tibialis anticus* in Man divides before its inser-

[1] *Op. cit.* p. 624. [2] *Op. cit.* p. 39. [3] *Op. cit.* p. 45.
[4] Proc. Zool. Soc. February 1865.
[5] Medical Times and Gazette, 1864, April 23rd, May 14th and 28th, June 11th. [6] *Nat. Hist. Rev.* Jan. 1862, pp. 83 and 88.
[7] *Loc. cit.* p. 319.

tion. The insertion-tendon of the *abductor pollicis longus* is also, he observes, "not seldom double"[1].

Theile makes no mention of the division of the former muscle in Man.

Extensor proprius hallucis.—Arises by a flat delicate tendon from about the middle third of the anterior edge or ridge of the fibula. It then runs obliquely outwards, till it passes under the strong pulley common to it and the *tibialis anticus*, when its direction is changed to one straight for its proper digit. At the astragalo-scaphoid articulation it becomes tendinous; and the straight continuation of the tendon, after expanding over the proximal phalanx of the hallux, terminates at the distal joint of this digit.

The tendon, moreover, a little posterior to the metatarso-phalangeal articulation, gives from its fibular side an offset to join one sent off to meet it from the inner of the *common extensor* tendons, which, after this junction, is continued to the base of the proximal phalanx of the second toe, there to join the expansion of the tendon of the *extensor communis* sent to this digit. This arrangement much resembles that which I have described and figured as existing in *Dasypus*, only that there is no pulley attached to the accessory ossicle which might serve to change the direction of the tendon of the *extensor hallucis*.

Rapp[2] describes the tendon of this muscle in *M. tamandua* as splitting into two branches, which pass to the first and second digits respectively, the latter of these branches entering also into communication with the tendon of the *common extensor*.

Extensor communis digitorum.—Arose by a strong flat tendon from the outer aspect of the external condyle of the femur, being covered by the lateral patellar ligament at this joint. It had scarcely, if any, origin from the tibia and fibula. Its muscular belly had about one-third of the bulk of that of the largely developed *tibialis anticus*. Just before it gains the dorsum of the foot, the muscle passes under a very strong ligamentous loop or pulley, which is attached to the anterior portion of the calcaneum, and, slightly, to the astragalus. Here it contracts, and divides into four equal-sized tendons.

The arrangement of these tendons, though at first sight somewhat complicated, may, I think, be best simplified thus:—The two innermost were fused together, so as to form a kind of aponeurotic expansion or web on the dorsum of the foot. This compound factor may be conveniently termed the "tibial" division. The "fibular" division was formed by a similar fusion of the two outermost tendons; and both "tibial" and "fibular" divisions had, moreover, a slight communication with each other.

The tendons, though thus fused together, may, however, each be traced with a considerable degree of certainty to its proper destination.

The first tendon, beginning from the tibial side, sent a branch to join that of the *extensor hallucis*; but the main portion was continued straight to the terminal phalanx of the second digit, expanding, however, over the metatarso-phalangeal articulation of this digit.

The second tendon passed to the tibial side of the tendinous expansion over the metatarso-phalangeal joint of the middle digit, and was also continued to the terminal phalanx. The expansion was joined on its fibular side by the inner of the two branches

[1] Muskellehre, pp. 211 and 276.

[2] *Op. cit.* p. 50.

into which the third tendon divides. The fibular branch of the third tendon, after joining the expansion over the metatarso-phalangeal joint of the fourth digit, was continued also to the terminal phalanx of this digit.

The fourth tendon passed to the terminal phalanx of the fifth digit, after joining the expansion over the metatarso-phalangeal articulation. This tendon may, possibly, take some share in forming what I have termed the *fibular* branch of the third tendon, but which Prof. Humphry describes as the *tibial* branch of the fourth[1].

Each of the tendons of the *extensor communis* had, at its metatarso-phalangeal expansion, a patella-like sesamoid bone developed in it, which bones appear to belong strictly to the deep layers which find attachment at the base of the middle phalanges of their respective digits.

These bones do not appear to have been present in the specimen examined by Prof. Humphry. Many of them are preserved in the skeleton of *Orcyteropus* in the Museum of the Royal College of Surgeons. A similar sesamoid, developed in a similar position, is present in the terminal tendon of the *extensor hallucis*.

Extensor brevis digitorum.—This muscle arose from the outer aspect of the calcaneum, superior to the origin of the *abductor minimi digiti*—also from the anterior portion of the bone, especially the tubercle which articulates laterally with the astragalus. It then passed obliquely forwards to be inserted into the inferior aspect of what I have termed the "fibular" division of the tendons of the *extensor communis*. It also joined, by means of two strong tendons, the tibial side of the second tendon and the fibular side of the first tendon respectively, of the above division, just before these expand over the metatarso-phalangeal joints of their proper digits—an arrangement which evidently favours the approximation of the second and middle digits, which are not bound together so closely as their homologues are in *Dasypus* by skin and subjacent tissue.

Another portion of the muscle is inserted fleshy into the first tendon at the point where it gives off the lateral branch to the tendon of the *extensor hallucis*. The *extensor brevis* does not appear to enter into any direct communication with the fourth tendon of the common *extensor*.

Prof. Humphry[2] describes this muscle as possessing three tendons; but the only distinct offsets deserving the term, in the animal which I examined, were those described as passing to the *extensors* of the second and middle digits.

Abductor minimi digiti.—Fairly developed. It is a flat muscular band, which takes origin from the smooth outer face of the calcaneal process, just below the origin of the preceding muscle, and has a broad fleshy insertion into the tubercle at the outer side of the base of the metacarpal bone of the fifth digit, and is also continued as a tendon to a sesamoid bone lying at the base of the proximal phalanx of the same digit.

Flexor brevis digiti quinti (Henle[3]).—This muscle arose slightly from the calcaneum, but principally from that portion of the plantar ligament which was inserted into the base of the metatarsal of the fourth digit. It gradually widened towards its termination, and had a fleshy insertion into the base of the proximal phalanx of the fifth digit.

Prof. Humphry makes no mention of this muscle as existing in his specimen.

Opponens digiti quinti (Henle).—This muscle, described by Prof. Humphry[4] under the

[1] *Loc. cit.* p. 317. [2] *Loc. cit.* p. 318. [3] Muskellehre, p. 301. [4] *Loc. cit.* p. 317.

name of *adductor minimi digiti*, took origin from the plantar ligament, at about the point of contact of the bases of the metatarsals of the third and fourth digits. After passing obliquely across to the tibial side of the fifth digit, it joined the lower layer of the *extensor* tendon on the dorsum of the proximal phalanx of this digit.

Plantar muscles of hallux.—A thin fusiform slip, taking origin from the anterior extremity of the ento-cuneiform bone, on its plantar aspect, and being inserted into the sesamoid at the fibular side of the base of the proximal phalanx of the hallux, in company with the terminal portion of the muscle termed by Prof. Humphry *adductor hallucis*.

This latter muscle, which may represent the outer (fibular) head of the *flexor brevis*, took origin from the strong plantar ligament, at the level of the base of the metatarsal of the second digit (the "middle metatarsal," according to Prof. Humphry).

The first-described muscle bears a great resemblance, both in origin and insertion, to one which I found last year in the right foot of a seaman at the "Dreadnought" Hospital Ship, and which is considered by Mr. Wood to be the plantar representative of the "*interosseus palmaris volaris*" of the hand[1].

Since, however, this muscle does not coexist with a complete set of the normal muscles of the hallux, a certain conclusion can scarcely be arrived at that it is the homologue of the above-described human "abnormality," seeing that either the *adductor hallucis* or the fibular head of the *flexor brevis* of this digit may lay just claim to it as a displaced representative.

As in the specimen described by Prof. Humphry, no proper *abductor hallucis* appeared to be present.

Lumbricales.—These muscles are four in number. They have origins similar to those of their homologues in *Dasypus*, arising in the interspaces of the tendons of the *flexor longus*, where these branch off from the common tendinous expansion of the muscle. They differ, however, in continuing single to their insertion, which is into the middle of the tibial side of the proximal phalanges of the second, third, fourth, and fifth digits. The hallux, it will be seen, unlike its homologue in *Dasypus*, has no *lumbricalis*.

These muscles resemble their homotypes in the upper limb in not being connected with the sheaths of the *extensor* tendons.

Cuvier gives a very good representation of them in one of his plates[2].

The Aï, according to Meckel[3], has no *lumbricales*, although the *flexor longus* is well developed.

Rapp mentions these muscles as present in *M. tamandua*[4], but makes no statement relative to their number or mode of termination.

The *Interossei* proper are confined to the three middle digits. They are six in number, and are so divided that each digit has one on either side.

[1] Proc. Royal Soc. May 1867, p. 543. I have Mr. John Wood's kind permission to correct here an error in his description of the muscle which forms the subject of this foot-note. My own description, which accompanied a copy of my original sketch, which I gave to Mr. Wood, was as follows:—"Muscular slip arising from the fascia in the neighbourhood of the articulation between the internal cuneiform bone and the metatarsal bone of the hallux, and of the insertion of the *tibialis anticus*, and becoming fused with the tendon of the outer head of the *flexor brevis* of the hallux. April 17, 1867."

[2] *Op. cit.* pl. 256. fig. 6. [3] *Op. cit.* p. 661. [4] *Op. cit.* p. 50.

They each arise from a side of the strong ligament, which passes, forked at both extremities, into a resemblance to an X, from the plantar aspect of the base of the metatarsal to the sesamoids at the base of the proximal phalanx of each digit, and are inserted into the sides of the lateral expansion of the *extensor* tendon at the metacarpo-phalangeal articulation, besides having attachment to the sesamoids at either side of the bases of the proximal phalanges of their respective digits.

Their action appears to be, especially when all united, principally one of flexion; separately, they might seem to abduct from, or adduct towards the middle line of the sole the digits to which they are respectively attached.

They who may have occasion to refer to this and to the preceding paper for facts (it is sincerely hoped that the descriptions of the muscular phenomena there noted are worthy of the name) may, perchance, expect to find at this stage a concluding colligation of these under a generalization of some sort. This, I fear, I am not prepared to offer; for neither can it be affirmed, on the one hand, that the muscular varieties which have been the subject of these pages have any precise morphological significance, nor, on the other hand, can they be regarded solely from a teleological point of view.

For, with regard to morphology, if muscular peculiarities are *not* to be regarded, as some hold, as "subsidiary to osseous arrangements," the converse can scarcely be maintained—namely, that osseous structures are not modifiable, at any rate as regards their offshoots (or "processes" as anatomists term them), by the condition of the development of the muscles which find attachment to these; for if this be not already granted, or, at all events, tacitly assumed, how comes it that (to take one out of many instances) in the exhumation of human remains for purposes antiquarian, ethnological, or medico-legal[1], the development of the processes of certain bones is taken greatly into account as an indication of the muscular condition, or even of the sex (in the absence of pelvic evidence), of the individual of whom these once were members?

Now these very bony processes, which are allowed to be affected by the muscles to which they afford attachment[2], are, in recent animals, in conjunction with the leading characters of other physiological systems, such as the digestive, generative, or nervous, chosen as a basis of classification. Take, for instance, the third trochanter on the femur of an Ungulate (possibly the niggard dole extorted by importunate muscular wants), which enables us to predicate of its once possessor that it was odd-toed, that its horn or horns (if any were present) were median, and not lateral, that its stomach was simple, while its cæcum was large and sacculated, and that the placenta which brought to it nourishment in fœtal life was of the "diffused," "non-deciduate" variety.

On the evidence, moreover, of such "processes," to a great extent, animals long since extinct are distributed among the classes which are provisionally formed for them and their modern representatives. By the aid of these, in great measure, have the *Mylodon*

[1] "The *bones* of the female are lighter, more cellular, less marked by asperities, and less curved by muscular action than those of the male; the processes are less strongly marked."—*Guy's 'Principles of Forensic Medicine,'* 2nd ed. p. 20.

[2] See Herbert Spencer's 'Principles of Biology,' vol. ii. p. 335 *et seq.* (Lond. 1867); Trousseau, 'Clinique Médicale,' tome iii. chap. 84, "Rachitis" (2ième édit., Paris, 1865).

and *Megatherium* found a place among the Sloths, and the *Glyptodon* supported a claim of kinship to the Armadillo[1].

If, on the other hand, the variations of muscles can reasonably be regarded as influenced by, or "as subsidiary to," the character of their bony attachments, before it can be determined what morphological value the former possess, we must first ascertain the probable amount of osseous influence which has been brought into play (a task towards the performance of which neither physiology nor pathology appears as yet to promise much aid), or, at all events, obtain a sure knowledge of the homologies of the subjacent bony framework (an inquiry in which, as regards the upper limb, the researches of Rathke and Parker will stand us in good stead, but in the case of the lower member there may yet be some groping about and stumbling); or, in default of such aids, the consideration of the skeleton must be set aside, and, regarding muscles *per se*, we must construct for our use "a typical vertebrate *myozoon*," to which, Procrustes-like, we can, as accurately as may be, adapt our muscular waifs and strays.

As regards teleology, it does not appear sufficient to consider the *end* of the general arrangement of the muscles of any given limb, to the exclusion of the special items contributed towards this end, or physiological total, by distinct muscles; for, to take an instance, if we content ourselves with the general observation that it is *burrowing* with which the muscular arrangement in the fore limb of the Armadillo, Aard-vark, and Mole appears to be chiefly concerned, we run the risk of overlooking the divers means by which this seemingly uniform result is brought about, and may omit to accredit an important share in the work, in the case of the two former animals, to the hugely developed and combined *triceps* and *dorso-épitrochlien*, and, in the case of the latter, to the *teres major*, a muscle which, as both Meckel and Cuvier have remarked, reaches an enormous degree of development in this animal[2].

Whether the likenesses or unlikenesses which certain muscular systems in *Dasypus* and *Orycteropus* may bear towards each other be due to a congruity, or the reverse, in their relations (be they morphological or teleological), or be brought about by a similarity or dissimilarity in *conditions* of existence (a plastic influence to which, according to

[1] The soundness of such claim, however, in the eyes of certain good authorities is by no means as yet distinctly proven. M. Pouchet, for instance, in a *résumé* of a paper upon the osteology of *Glyptodon clavipes*, *G. giganteus*, and *Hoplophorus euphractus*, remarks, "Ceci tient, comme nous l'avons dit, à ce que nous manquons des points de comparaison nécessaires, puisque nous ne connaissons complétement à peu près aucun de ces animaux. Ce n'est pas avec le cou des uns, le bassin des autres, la carapace de ceux-ci et la queue de ceux-là qu'on peut faire des distinctions ou des rapprochements définitifs, les animaux semblables par un de ces points pouvant différer énormément pour tous les autres."—*Contribution à l'Anatomie des Édentés, par Georges Pouchet*, Ch. Robin, Journ. de l'Anat. et de la Physiol. vol. iii. p. 351, 1866.

[2] Meckel says of this muscle (*op. cit.* p. 500), "Ungeheuer stark, wohl am stärksten ist er bein Maulwurf, wo er den ganzen Untergrätenmuskel bedeckt."

The same muscle is clearly represented by Cuvier in one of his figures of the myology of the Mole (Anat. Comp. pl. 80); and in the short notes appended to the plate, it is stated that "Le grand rond est extrêmement puissant et tellement saillant que dans la fig. 1 on pourrait croire qu'il se fixe au cubitus."

In the Mole-Rat of the Cape (*Mus Capensis*, Linn.), the *teres major* does not attain so great a development (see pl. 216, *op. cit.*); for "au lieu de fouir avec la rapidité merveilleuse que montrent ces insectivores (Taupes) pour atteindre les larves d'insectes ou les vers, les Rats-Taupes, qui vivent de racines, cheminent plus lentement dans leurs galeries."

some, due weight has not yet been given in biological speculations[1]), is a question of which, from the quantity and the quality of the facts at my disposal, I confess myself unable to offer a satisfactory solution; and, as a slight excuse for my reluctance to generalize, I bring forward, in conclusion, the following words of a great thinker[2]:—"General observations drawn from particulars are the jewels of knowledge, comprehending great store in a little room; but they are therefore to be made with the greater care and caution, lest, if we take counterfeit for true, our loss and shame be the greater when our stock comes to a severe scrutiny."

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[1] "Mr. Darwin's Hypotheses, by George Henry Lewes," Parts I. and III. Fortnightly Review, April (p. 372) and July (p. 78) 1868.

With regard to habits, these two animals agree in their mode of procuring food; and therefore a certain general, and even special, similarity in the structure of their limbs may reasonably be expected; but, on the other hand, the restricted ant-diet of the sluggish Aard-vark must cause this animal to differ in some points from the omnivorous, and even "ghoul"-like (see Azara, 'Essais,' vol. ii. p. 127, and Rengger, 'Säugethiere von Paraguay,' p. 281), active Armadillo. For some very suggestive remarks upon the respective values of *kind* of food and the *manner in which such food is procured*, as foundations for classification, see Andrew Murray's 'Geographical Distribution of Mammals,' p. 219.

[2] Locke, 'On the Conduct of the Understanding.'

[3] It were unjust of me not to acknowledge here the great obligations under which I am to Prof. Rolleston for placing in my hands for reference a large proportion of the works included in the following list.

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EXPLANATION OF THE PLATES.

Plate XLV.—Principal Muscles of the Upper Extremity.

Fig. 1. Inner aspect of Arm and Forearm, together with contiguous portions of Trunk, and Radial half of Extensor surface of Forefoot. Left side.

P C. Panniculus carnosus.
M S. Musculus sternalis.
A B. Acromio-basilar.
D H. Dermo-humérien.
S M. Sterno-mastoid.
C M. Cleido-mastoid.
S. Scalenus.
O E. Obliquus externus.
S C. Subclavius.
D. Deltoid.
P M. Pectoralis major.
P M N. „ minor.
L D. Latissimus dorsi.

C B. Coraco-brachialis.
B. Biceps.
D E. Dorso-épitrochlien.
T. Triceps.
E A. Epitrochleo-anconeus.
S L. Supinator longus.
S B. „ brevis.
E C R. Extensor carpi radialis.
E O M P. „ ossis metacarpi pollicis.
E C D. „ communis digitorum.
P T. Pronator radii teres.
F C R. Flexor carpi radialis.
F S D. „ sublimis digitorum.
F C U. „ carpi ulnaris.
F P D „ profundus digitorum.
A B I. Abductor indicis.
L. Lumbricalis.
* Submaxillary Gland.

Fig. 2. Middle layer of Muscles at Upper part of Thorax, left side.

R A. Rectus abdominis.
E O. Obliquus externus.
E I. External intercostals.
S. Scalenus.
P M N. Pectoralis minor.
P M. „ major.
S C. Subclavius.
S M. Sterno-mastoid.

Fig. 3. Deep palmar muscles, including Interossei, right side.

P T. Pronator radii teres.
P L. Palmaris longus.
F C R. Flexor carpi radialis.
F S D. „ sublimis digitorum.
F P D. „ profundus digitorum.
F C U. „ carpi ulnaris.
P Q. Pronator quadratus.
A M D. Abductor minimi digiti.
L. Lumbricalis.

* Annular ligament. (The flattened oval sesamoid is seen in the ulnar half of the divided ligament.)

PLATE XLVI.—Principal Muscles of Lower Extremity.

Fig. 1. Inner aspect of thigh, and extensor surface of leg and foot. Left side.

I P. Ilio-psoas.
G R. Gracilis.
S. Sartorius.
S M. Semimembranosus.
S T. Semitendinosus.

P. Pectineus.
O E. Obturator externus.
A B. Adductor brevis.
A L. „ longus.
A M N. „ minimus.
R. Rectus.
V I. Vastus internus.
G. Gastrocnemius.
T A. Tibialis anticus.
E C D. Extensor communis digitorum.
E P H. „ proprius hallucis.
E B D. „ brevis digitorum.
P L. Peroneus longus.
P B. „ brevis.
P T. „ tertius.
P Q. „ quinti digiti.

Fig. 2. Muscles connected with the Great Trochanter. Right side.

G M X. Glutæus maximus.
G M D. „ medius.
G M N. „ minimus.
P Y. Pyriformis.
O I. Obturator internus.
G S. Gemellus superior.
G I. Gemellus inferior.
A M N. Adductor minimus.
S T. Semitendinosus.
S T_2. Semitendinosus, second portion.

Fig. 3. Deep plantar muscles, including Interossei. Left side.

S O. Soleus.
P L N. Plantaris.
T A. Tibialis anticus.
T P. Tibialis posticus.
P L. Peroneus longus.
P B. „ brevis.
P T. „ tertius.
F L D. Flexor longus digitorum.
F A. Flexor accessorius (rudimentary).
E B D. Extensor brevis digitorum.
L. Lumbricalis.
A B M D. Abductor digiti minimi.
F B D Q. Flexor brevis digiti quinti.
O D Q. Opponens digiti quinti.
A H. Adductor hallucis.
F B H. Flexor brevis hallucis.

* Accessory ossicle of Entocuneiform bone.

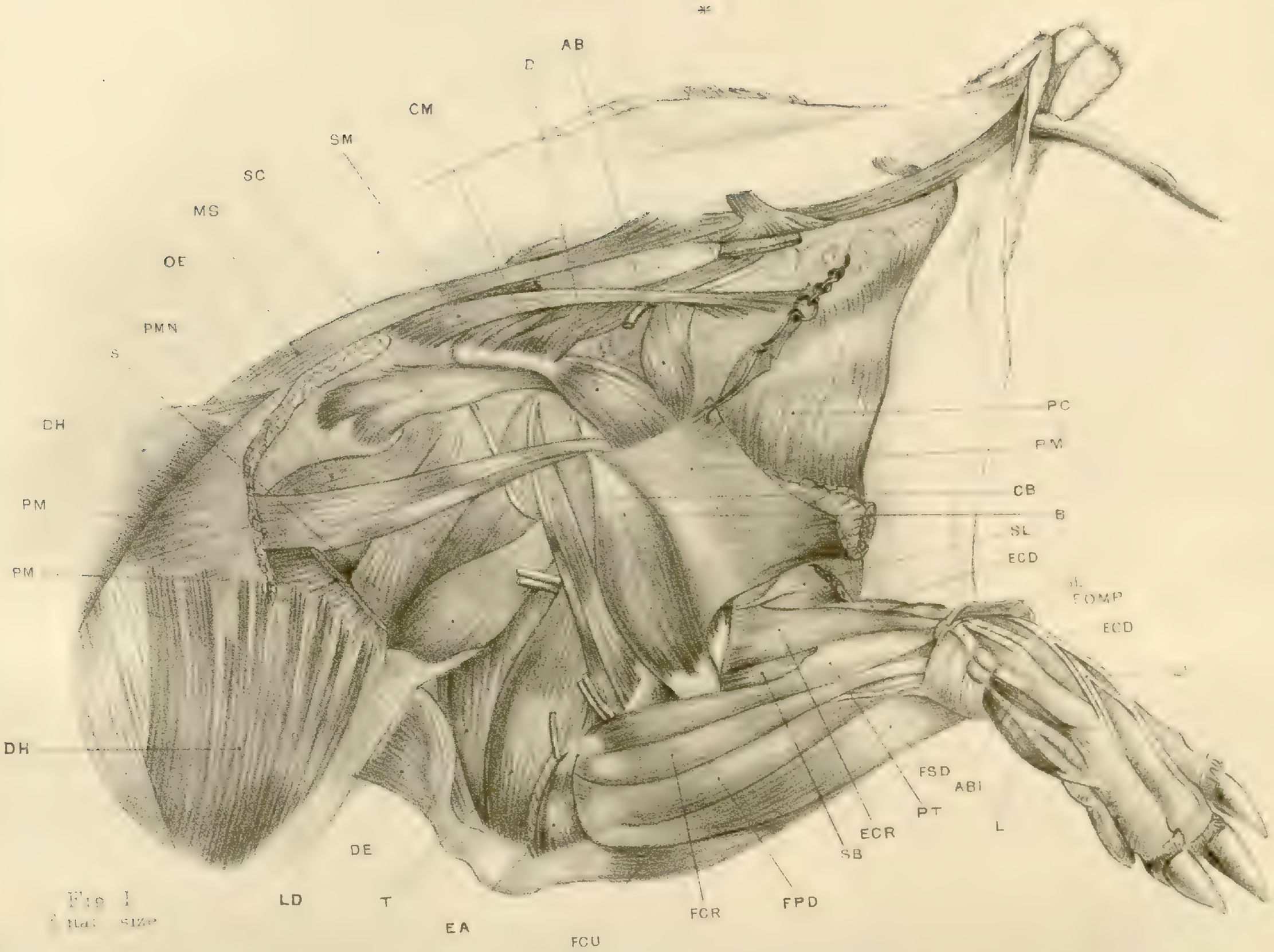

Fig. 1
Half size

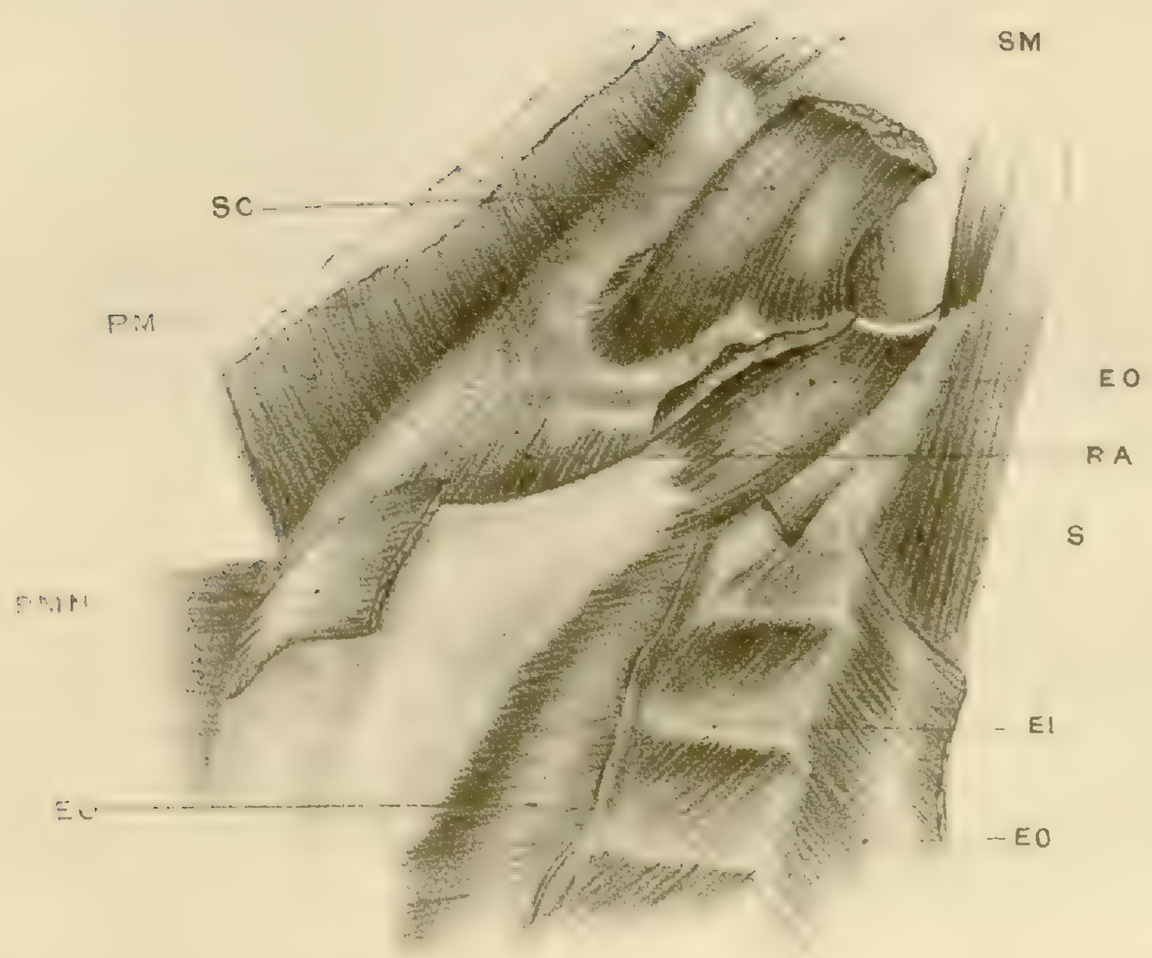

Fig. 2. $\frac{3}{10}$ nat size

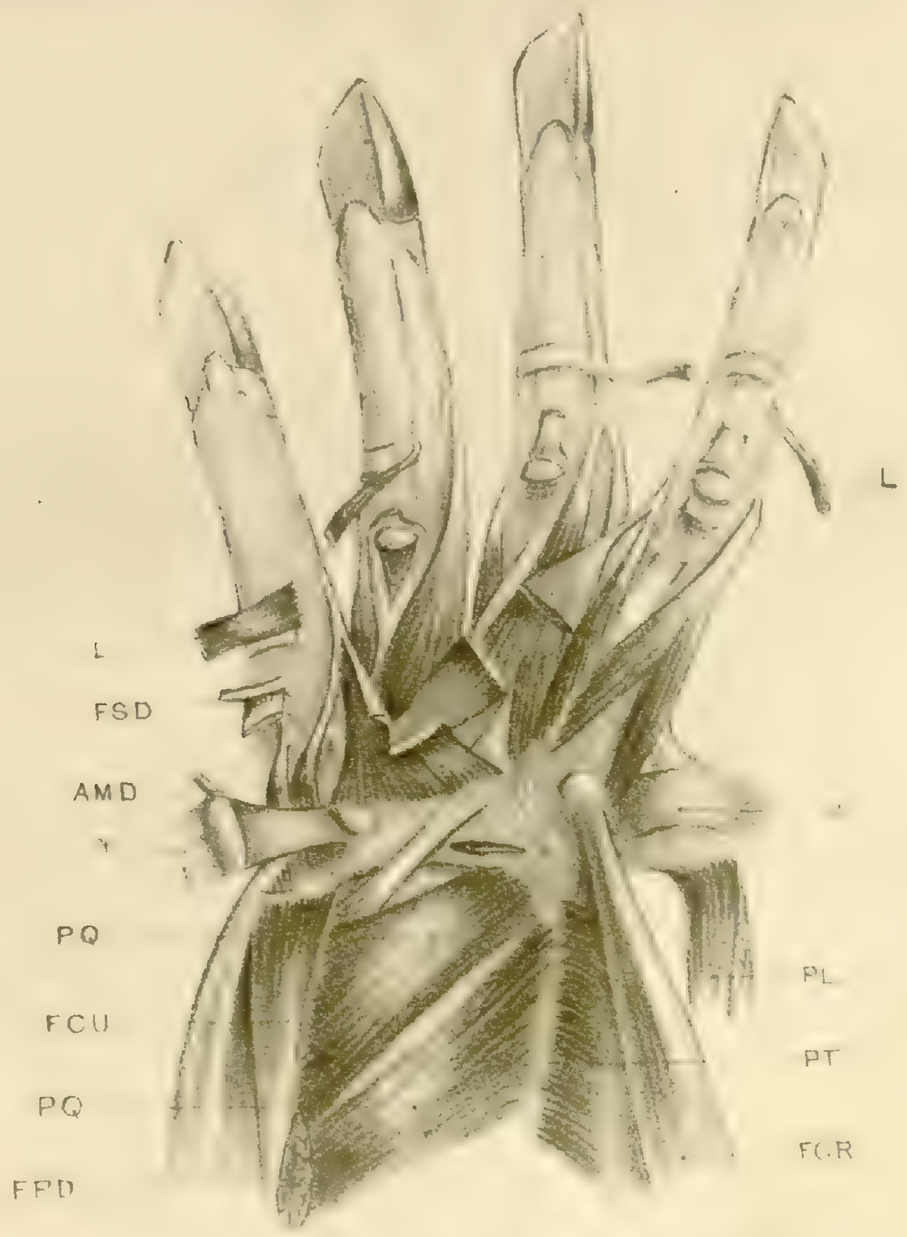

Fig. 3 $\frac{1}{2}$ nat size

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W West imp.

ORYCTEROPUS CAPENSIS.

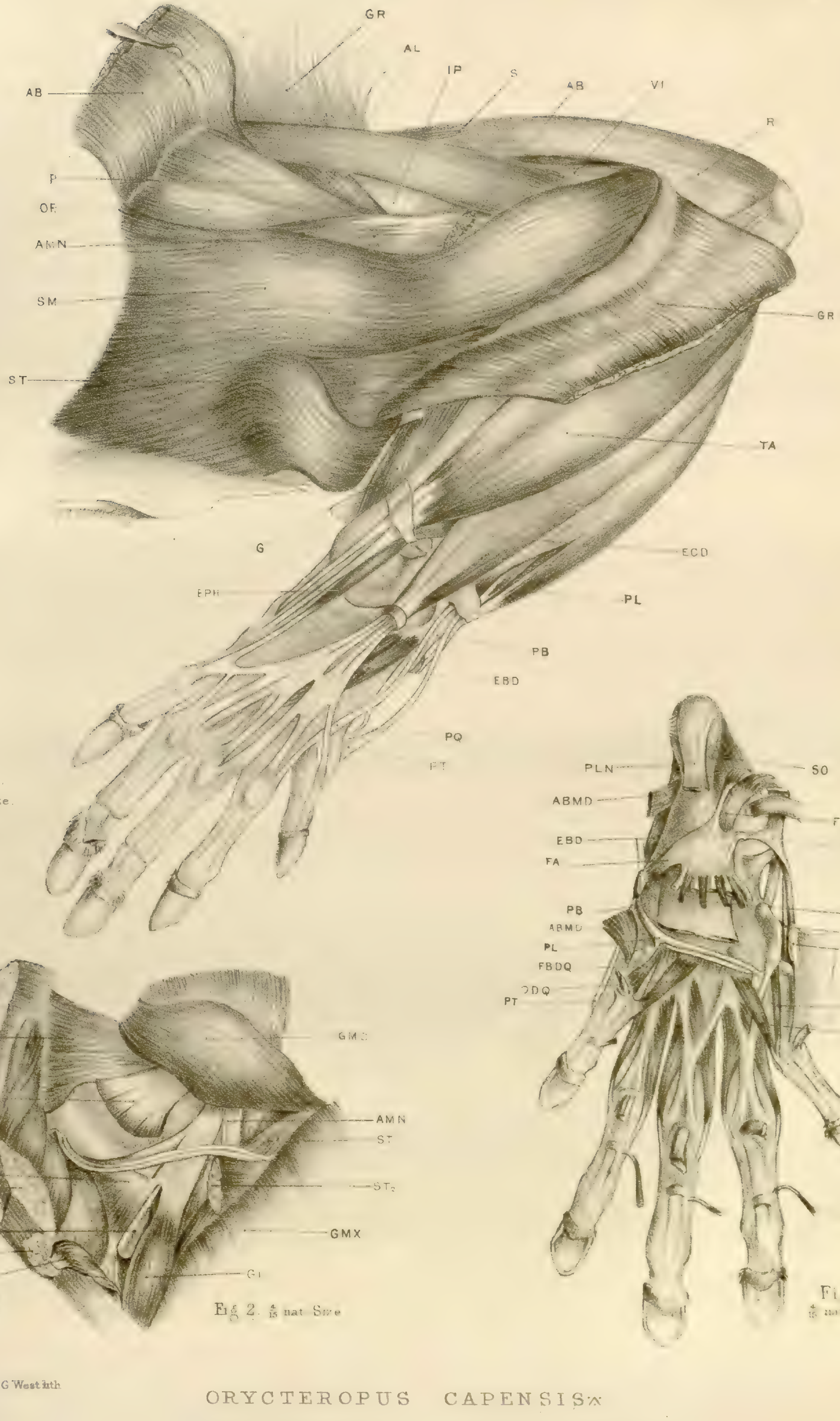

Fig. 1.
$\frac{4}{15}$ nat. Size.

Fig. 2. $\frac{4}{15}$ nat Size

Fig. 3
$\frac{4}{15}$ nat. Size

J.C. Galton del. 1868. G. West lith.

ORYCTEROPUS CAPENSIS.

W. West imp.

XIII. *On the Homologies of certain Muscles connected with the Shoulder-joint.*

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(Plate XLVII.)

Read June 14th, 1868.

The main points of the paper which I have herewith the honour of laying before the Linnean Society are, first, that the *pectoralis secundus s. levator humeri* of birds finds its homologue in the *subclavius* of mammals, and not in the *pectoralis minor* of anthropotomy, and, secondly, that the "epicoraco-humeral" muscle, as described by Mr. Mivart in the *Echidna hystrix* and in the *Iguana tuberculata*, is the homologue of the two former of the three muscles now mentioned. A minor issue will be raised as to the source whence the sternal factor of the avian *levator humeri* comes to be added to the reptilian epicoraco-humeral, which, as its name implies, has no such mesial point of origin: and it may be stated at once that, though the mammalian *subclavius* furnishes instances of two methods whereby the *subclavius* of Man may acquire such an accessory point of origin, viz. either by borrowing from the *rectus abdominis*, or by simple apposition to its head, from the cartilage of the first rib, of fibres from the præsternum on which it abuts; the analogy of other animals seems to point to its being in this latter way that this addition is made. Some other points of less moment will arise in the discussion of these questions, or be brought forward at the conclusion of the argument as to the pectoral muscles. Of the four figures which accompany this paper, the first two represent the bony structures of the shoulder-girdle of the Crocodile, and the coraco-scapular bone of the Emu; whilst the third and fourth represent certain of the muscles arising from these bones and passing to the upper extremity in either case. Dissections from these two animals have been chosen for figuring, amongst other reasons, because the structural arrangements of the classes to which they respectively belong express, as has been remarked by anatomists from the time of Meckel ('Vergleichende Anatomie,' vol. iii. p. 194) to that of Mr. Parker ('Shoulder-Girdle,' 1868, pp. 142, 192), certain of the problems of morphology in plainer language than those of most other animals. It was whilst dissecting these and other animals in the light furnished me by Mr. Mivart's papers on the myology of the *Echidna hystrix* (Trans. Linn. Soc. xxv. 1866) and the *Iguana* (Proc. Zool. Soc. June 27, 1867)[1] that I came to entertain the

[1] In the former of these two papers (at p. 395) a very extensive, if not exhaustive, bibliography was given of the many disquisitions which had previously appeared on the subject of the Homology of the limbs and their muscles. To Mr. Mivart's list the following memoirs may be added, most of which are either contemporaneous with or posterior in date to his paper.

Hermann Pfeiffer. Zur vergleichenden Anatomie des Schultergerüstes. Giessen, 1854.

Professor Haughton. "On the Muscular Anatomy of the Crocodile," Proceedings of the Royal Irish Academy, June 26, 1865; Ann. and Mag. of Nat. Hist. Ser. iv. No. 4, April 1868.

Dr. Macalister. "On Irregularity in the Muscles of the Shoulder," and "On the Homologies of the Flexor

views which I now put forth, and in which I should have more confidence if I knew them to be in accordance with his views.

The *pectoralis secundus s. levator humeri* of ordinary birds arises from a greater or less extent of the keel and lateral portions of their sternum; and narrowing into a tendon as it passes along the inner aspect of the coracoid and the inferior surface of the coraco-clavicular membrane, from both of which structures it may receive an accession of muscular fibres, it winds over a pulley formed for it by the bone just mentioned, to be inserted between the insertion of the great pectoral on the radial tuberosity of the humerus, internally, and the tendon of the deltoid as it passes down to its attachment on the outer aspect of the bone, externally. The tendon of the *levator humeri* holding thus an intermediate position between the tendons of the deltoid and the great pectoral, may receive an accession of muscular fibres from the mesoscapular portion of the scapula; or these fibres, which may have a separate nerve-supply, may have also a separate insertion from that of the *levator* on the humerus. But the pulley arrangement furnished by the coracoid enables the *levator* in its simplest form to act as a powerful *levator* of the humerus.

The "subclavius" of anthropotomy arises from the cartilage of the first rib, a region into the constitution or near neighbourhood of which Mr. Parker has shown the epicoracoid to enter in several mammals[1]. Under cover of a dense fascia (the "costocoracoid membrane," which may be taken to represent in fibrous tissue[2] an aborted large-celled

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Muscles of the Vertebrate Limb," Cambridge Journal of Anatomy and Physiology, May 1867. "On Muscular Anomalies, and their bearing on Homotypical Myology," Proceedings Royal Irish Academy, December 9, 1867. "Contributions towards the formation of a correct System of Muscular Homologies," Ann. and Mag. of Nat. Hist. Ser. iv. No. 5, May 1868.

Dr. Hair. "On the Arrangement of the Muscular Fibres of the Alligator," Cambridge Journal of Anatomy and Physiology, November 1867.

Professor Pagenstecher. "Ein Vergleich der Muskulatur des Drill mit der des Menschen," Der Zoologische Garten. Zeitschrift für Beobachtung, Pflege und Zucht der Thiere, April and May 1867, Frankfort.

W. F. Vrolik. Den Carpus der Zoogdieren. 1866. Leiden.

Wood. "Varieties in Human Myology," Proc. Roy. Soc. vol. xiii. p. 299 (June 16, 1864), vol. xiv. p. 385 (June 1865), vol. xv. p. 239 (June 1866), p. 524 (May 1867). "The Comparative Anatomy of the Muscles of the Shoulder," Cambridge Journal of Anatomy and Physiology, November 1866.

Jeffries Wyman. "On the Symmetry and Homology of Limbs," Proc. Boston Nat. Hist. Soc. vol. xi. June 1867, ibique citata.

My thanks are due to Messrs. Vrolik, Mivart, Haughton, Wood, and Wyman, for their courtesy in sending me copies of their papers, several of which were thus rendered accessible to me much earlier than they otherwise would have been. Mr. Parker's magnificent volume on "the Shoulder-Girdle," recently (1868) published by the Ray Society, furnishes, here and there, hints and guidance for the determination of muscular homologies which no writer can for the future afford to ignore. One of the many pleasing fruits of studying this work is the feeling that by so doing one has fairly earned a right to spare one's self the task of criticising views which must have been formed before Mr. Parker's labours were published.

[1] See 'Shoulder-Girdle,' pl. 26. fig. 10, *Mus decumanus*; fig. 5, *Mus minutus*; figs. 1 and 2, *Mus musculus*; fig. 5, *Mus sylvaticus*.

[2] For the representation in fibrous tissue by adult structures of what was cartilage in the embryo, see Parker, *loc. cit.* pp. 182, 184, 197, 198. For the existence of the cartilaginous band, above mentioned, see Gegenbaur, 'Untersuchungen zur vergleichenden Anatomie,' 1865, vol. ii. pp. 15–17, cited, Parker, *loc. cit.* p. 223. Prof. Pagenstecher, who, however, does not mention Prof. Gegenbaur's discovery, speaks, in the description of the dissection of a Drill,

cartilaginous band which reached in the embryo from the acromion to the præsternum) the *subclavius* of Man passes up to be inserted into the costal surface of the outer half of the clavicle. The relation held by this fascia to the muscle furnishes, as I shall hereafter strive to show, a most important means for differentiating the *pectoralis minor* of the Mammal from its *subclavius*. The variations which the *subclavius* presents in anthropotomy cast light, as such variations sometimes do, upon its homological representatives in the lower animals. One of the most important of these variations is the junction to the *subclavius* of another muscle, which, as arising ordinarily from the sternum, may be called a "sternoclavicular" muscle[1], and may be thought, by virtue of this its point of origin, to supply to the human *subclavius* the sternal factor which it requires to make its origin co-extensive with that of an avian *pectoralis secundus*. The prolongation of the *subclavius* to the acromion and scapula, so very common in quadruped mammals, is rare in the human subject, its fibres appearing to be, as it were, arrested by the largely developed distal end of the clavicle. One instance of such an arrangement is given as follows by Mr. Wood in the 'Proceedings of the Royal Society,' June 1865, p. 384.

"In a thin female subject of low stature was found, on the right side only, the remarkable muscle given in fig. 4. It consisted of a roundish fusiform slip (*a*), arising tendinous from the first cartilage below the *subclavius*, close to the *manubrium sterni*, passing across the subclavian vessels and nerves, quite distinct from the last-named muscle, and inserted into the upper border of the scapula and suprascapular ligament, where it was connected, to some extent, with the origin of the *omo-hyoideus* (*e*). From this point of insertion another slip of muscular fibres passed forwards, upwards, and outwards, to be inserted, with the *subclavius*, into the outer third of the clavicle.

"This muscle seems to be the same as that given in the author's first series under the name of a double *subclavius*, with the addition of a connecting slip to the clavicle. It seems to the author to represent pretty closely the *sternoscapular* muscle, while contributing to support the thorax in the Pachyderms and Ruminants, in which animals it is continued as far as the manubrium."

It is singular that in the Crocodile some of the fibres of the *omohyoid* are, in young specimens at least, continuous with fibres of the *epicoraco-humeral*; and it is obvious that if, in the case just quoted from Mr. Wood's paper, the fibres thus continuous with the *omohyoid* had been prolonged a little, so as to become continuous with those of the *deltoid* or *supraspinatus*, we should have had here a muscle corresponding both in origin and in insertion very closely with the *pectoralis secundus s. levator humeri* of the bird.

Now, as the following account of a dissection from the Guineapig will show, just such a muscle exists in that animal:—

In the Guineapig (*Cavia aperia*) the *subclavius* muscle, the smaller "sternoscapular" of Mivart and Murie (Proc. Zool. Soc. June 1866, p. 398) arises from a small surface on

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Mandrilla leucophæa (Zool. Gart. April 1867, p. 128), of a very fine but strong elastic band, which ran along the upper or anterior border of the *pectoralis minor* from the coracoid to the anterior end of the second rib, as being the homologue probably of the coracoid of Monotremes, Birds, and Reptiles.

[1] For instances of this "second subclavius" see Wood, Proc. Roy. Soc. June 1864, p. 300, June 1865, p. 384, and June 1866, p. 238; Macalister, Proc. Roy. Irish Acad. Dec. 1867.

the præsternal proosteon and from the cartilage of the first rib, exteriorly to which latter point of origin the epicoracoid has coalesced with the vertebral rib. It passes up behind the osseo-cartilagino-fibrous bar made up of ligaments, præcoracoid, clavicle, and meso-scapular segment (see Parker, *l. c.* pl. 24. fig. 6) and reaching from the apex of the anterior prolongation of the sternum to the acromion and coracoid. Some of its fibres are inserted into the coraco-clavicular ligament, and some, though fewer, into the clavicle itself. But from the clavicle it receives a large accession of muscular fibres in return; and these, joining with the fibres of the original muscle, pass on to be inserted along the anterior edge of the acromion, and also to become continuous along the mesial or down-ward-looking edge of the metacromion with fibres of the deltoid, which take origin from the ligament prolonged inwards from the acromion to the clavicle. Thus, though the greater part of the fibres of the *subclavius* are arrested by a bony fixation into the acromion, which, it will be recollected, is, in these proportions at least, an exclusively mammalian development, it becomes, by the continuity of its innermost fibres with the soft tissues placed mesially to that process, more or less physiologically as well as morphologically equivalent to the *pectoralis secundus* or *levator humeri* of the bird. A larger muscle, the larger "sternoscapular" of Mivart and Murie, arises from the mesosternum in the Guineapig, and takes a similar course to that of the "subclavius," with which it interchanges fibres at the clavicle, to which they both have an attachment. It is inserted, however, along the upper vertebral border of the scapula; and three-fifths of the entire length of the spine of that bone intervene between its insertion and that of the *subclavius*. If we consider that the "subclavius" here has an origin, as it has also in the Crested Agouti, *Dasyprocta cristata* (Mivart and Murie, *l. c.* p. 398), and in other mammals, from a sternal as well as from a costal element in immediate connexion with the epicoracoid, and, indeed, also with the præcoracoid, we may think ourselves justified in regarding the muscle with these points of origin as the morphological equivalent, as to its origin at least, of the entire *pectoralis secundus* of the bird, independently of the "greater sterno-scapular" muscle. But, inasmuch as the *pectoralis secundus* of the bird shows some tendency to self-multiplication, as seen in the suborder Gallinæ, it may be well to consider the two sternoscapular muscles as, either severally or fused, homologous with either two distinct *pectorales secundi* or a single one. The *rectus abdominis* is prolonged up to the first rib, and is overlapped in the Guineapig by a muscle homologous with that figured at *e o* in fig. 3, of the Crocodile's shoulder-joint muscles; but it does not give any tendinous or muscular factor to the *subclavius* here, as it does in the Wombat (*Phascolomys wombat*). A description of the arrangement of these parts in this latter animal will be found in my description of fig. 3, which, though taken from a dissection of a Crocodile, makes the account of the structures, as seen in the Wombat, much more intelligible. Both descriptions alike warn us not to lose sight of the possibility that the avian *levator humeri may* have borrowed a factor from the anterior prolongation, over the sternum, of the *rectus abdominis*. The arrangement of these selfsame structures in the Aardvark (*Orycteropus Capensis*) enforce the same lesson. In this animal (a detailed account of the myology of which, by J. C. Galton, Esq., appears in the Linnean Society's 'Transactions,' vol. xxvi. p. 571) the *subclavius* arises from the manubrium, from the cartilage of the first rib, and

from the tendon of the rectus abdominis as it passes upwards to be inserted into the manubrium and first rib. The muscle is folded upon itself much as the *pectoralis major* is in the human subject; the concavity of the pouch thus formed looks inwards. The inferior or superficial portion of the muscle passes upwards; and its tendon spreads into the fascia covering the *supraspinatus*, and thus is inserted into the acromion at its root, whilst towards its apex, by the intermediation of fascia covering the acromion, it can act upon the fibres of the deltoid taking origin there. The portion of the muscle which lies deeper or more dorsally is inserted into the coracoid, into and along the coraco-acromial ligament, into a detached ossicle, which lies outside the angle formed by the meeting of acromion and clavicle, and finally into the clavicle. But the clavicle seems to give fibres to the *subclavius*, as well as to receive the insertion of fibres from it; these fibres, however, are but few in number, and seem to lie between the superficial and the deep portions of the muscle.

The *subclavius* of certain New-World Monkeys (*Mycetes seniculus* and *Mycetes Geoffroyi*) furnish us with a stepping-stone whereby to pass from the *subclavius* of the three mammals just treated of to the *subclavius* of anthropotomy. In these Monkeys the *subclavius* takes origin from the junction of the first costal cartilage, not with the sternum, but with the rib, and it is inserted into the outer and under surface of the clavicle and into the coracoid. But it has no origin from the sternum, and no scapular nor any humeral insertion, either direct or indirect.

The human *subclavius* may have an insertion into the coracoid (Wood, Proc. Royal Soc. June 1864, p. 300); but such an aberrant slip as that recorded by Ganzer (cited by Mr. Macalister, Cambridge Journal of Anatomy, May 1867, p. 318) as passing in the human subject "from the cartilage of the first rib to the capsule of the shoulder beneath the *pectoralis minor*" I should be inclined to look upon as merely a part of the deeper layers of the *pectoralis major*, which took origin as much higher than those layers do ordinarily reach as the slip of muscle *e o*, figured from the Crocodile in fig. 3, appended to this paper, takes origin higher than the external oblique does ordinarily.

I may now pass by a natural transition to a vindication of my proposition, that the *pectoralis secundus* or *levator humeri* of the bird does not find its homologue in the *pectoralis minor* of the mammal. For the establishment of this negative proposition, it is not sufficient to say that in each of the mammals from dissections of which I have described a *subclavius* apparently homologous in origin, course, and insertion with the avian *pectoralis secundus* a muscle homologous with the human *pectoralis minor* is also found, and that this coexistence disproves the view which asserts these two *pectorales* to be homologous; for the *pectoralis minor* may be multifid, and many instances have been put on record in which it forms a groove for a portion of its fibres in the coracoid and, working in it as over a pulley, comes, either directly or through the intermediation of the *supraspinatus* (which these fibres join), to act as an elevator of the humerus (see Macalister, Proceedings Royal Irish Academy, Dec. 1867; Cambridge Journal, May 1867, p. 317; Wood, Proceedings Royal Society, May 1867, p. 524, June 1866, p. 231); and it is plain *à priori* that for the formation of an avian *pectoralis secundus* by the *pectoralis minor*, and for the alteration of its functions from that of a depressor into that of a *levator*

humeri, all that is necessary is the provision for its tendon of some such pulley-like arrangement by the coracoid. What I have to show is that, as a matter of fact, the muscle which, in the economy of nature, has been worked up into the avian *levator humeri* is one and not the other of two, either of which, so far as we can see, might have been so employed.

I cannot adopt Prof. Pagenstecher's views (Zool. Gart. April 1867, p. 125), according to which the two mammalian *pectorales* are referred to two entirely distinct sets of muscles, the *pectoralis major* being one of a ventral, and the *pectoralis minor* one of a dorsal series. The single fact of their both receiving a nerve-supply from the same nerve (the internal anterior thoracic) seems to be conclusive against the validity of this suggestion. And I believe further that it is impossible to observe how the posterior fascicles of the *pectoralis major* in the lower mammalia have their tendons prolonged up from the lesser tuberosity of the humerus and the bicipital groove, which is bridged over by pectoral tendons, to the coracoid process without being convinced that the *pectoralis minor* of anthropotomy is but a specialized anterior fascicle of the deeper portions of the *pectoralis major*. The commonest variation, according to Mr. Macalister (Cambridge Journal of Anatomy and Physiology, May 1867, p. 317), which the *pectoralis minor* exhibits in Man is an insertion of the lowest part of its tendon, missing as it were the coracoid process, into the *coraco-brachialis* muscle.

The arguments which I shall now adduce to show that the *pectoralis minor* is not the homologue of the avian *pectoralis secundus* will at the same time go some way towards proving that the primary insertion of the mammalian muscle is a humeral one, more or less internally to the tendon of the superficial layers of the greater pectoral, whilst the primary insertion of the avian is also a humeral one, but one more or less externally placed to that of the great pectoral depressor of the humerus. The attachment of the mammalian pectoral to the coracoid is secondary in its history; and the like place in the series of its specializations is held by the development of the coracoid pulley in the history of the avian *pectoralis secundus*. The insertion of the "subclavius" into the clavicle and the junction of the "*pectoralis minor*" with the *supraspinatus* will be seen in the course of the argument to be exclusively mammalian developments. Now there are three lines of argument for showing the homological identity or non-identity of any two muscles. The first line of argument shows that they hold the same or different relations to the other structures they are connected with at their origin, in their course, or at their insertion. The second shows that they are or are not supplied by the same nerve or nerves. The third shows that either in their adult condition or in the condition of development they are independent or connate. A comparison of the *pectoralis minor* of the mammal with the *pectoralis secundus* of the bird furnishes us, under each of these three heads, with an argument for their non-identity. Under the first head I would observe, as Prof. Pagenstecher has already been quoted as doing, that the *pectoralis minor* of the mammal lies to the outer side of the costocoracoid membrane, to the inner side of the homological representative of which structure, viz. the coracoid, the *pectoralis secundus* of the bird passes. I do not mean to deny, nor yet to affirm, that the *pectoralis minor* of the mammal may not be one of the same series of

muscular fasciculi as its *subclavius*; what I do affirm is, that there is a certain landmark between these two muscles enabling us to separate them into two sets, and that there is a similar separation recognizable in the bird, of similar muscles by means of a similar landmark. Under the second head I shall show that the subclavius of the mammal is supplied by a nerve homologous with the nerve which supplies the *pectoralis secundus* of the bird, and that the *pectoralis minor* is not supplied by that nerve, but by the same nerve as that which in the bird supplies the great pectoral. And, thirdly, I shall show that in the developing bird it is possible to see that the *pectoralis major* is really the equivalent of both pectorals of the mammal. The facts of the anatomical arrangements in any single bird will give my arguments in their most intelligible form; and I will proceed to give them in an account of the structures in question, as seen in the common Sparrow-Hawk (*Accipiter Nisus*).

The *pectoralis secundus s. levator humeri* has a much smaller area of origin from the sternum and its keel in the Sparrow-Hawk (*Accipiter Nisus*) than in the Common Fowl. It receives, however, an accession of fibres, first from the anterior inferior angle of the coracoid, and secondly from a large head which, arising from the posterior or upper surface of the coracoid groove in the sternum, from the lateral aspect of the sternal rostrum, from the upper surface of the inner angle of the coracoid itself, and, finally, from the upper surface of a fibrous band which passes from the posterior lip of the coracoid groove in the sternum to fix itself to the posterior and inner edge of the coracoid at about the middle of the height of the bone, may be considered the homologue of the large "coraco-brachialis superior" of Gallinaceous birds*. A dense band of ligamentous tissue (homologous probably with the præcoracoid of the Lizards) stretches in the coraco-clavicular membrane from the sternal rostrum to the upper end of the clavicle; and from it a thin sheet of muscular fibres arises, which joins the tendon of the *pectoralis secundus* in the pulley, as does also a slender slip of muscle which passes from the mesoscapula. The main mass of the *pectoralis secundus* is of a deeper colour, especially in young birds, than these two latter muscles, which join its tendon; and it is to be remarked that the main mass, as well as the former of these accessory slips, takes origin from the fibrous band in the coraco-clavicular ligament.

A ligament passes from the anterior exterior angle of the coracoid at its sternal articulation (the "epicoracoid" of Parker) to be inserted on the sternum at a point about opposite the articulation of the third sternal rib. It limits the fibres of the *pectoralis secundus* mesially from those of the so-called "subclavius" (no. xi. of Schoepss †) externally, at the point where these latter pass upwards and inwards to attach themselves to the base of the coracoid. Inasmuch, then, as the two layers of the "subclavius" of the bird are homologous serially with the two layers of the intercostals, this ligament may be considered homologous with the mesial attachment of the costo-cora-

* The lower part of this latter muscle is aborted as far as its ordinary direction is concerned, its upper part being represented by a very slender slip which arises from the posterior aspect of the mesocoracoid region close to the glenoid, and, taking the usual course of a coraco-brachialis, is inserted with the subscapularis.

† "Beschreibung der Flügelmuskeln der Vögel. Von C. G. Schoepss," Meckel's Archiv, 1829, p. 72.

coid membrane which separates the "subclavius" of the mammal from the insertion of the internal intercostals, the serial homologues of the deep layer of the *subclavius* of the bird.

Secondly, the nerve which supplies the *pectoralis secundus* of the bird is obviously homologous with the nerve which supplies the subclavius of the mammal, and not with the nerves which supply the greater and lesser pectorals in that class. The nerve to the bird's *pectoralis secundus* comes, in the *Accipiter Nisus*, from the anterior factors and lower aspect of the brachial plexus; and the nerve corresponding to the external respiratory of Bell comes off from the dorsal surface of the same part of the plexus, just as the subclavius and external respiratory do in Man, whilst the nerve to the great depressor pectoral muscle comes off lower down, and does not send any branch to the *pectoralis secundus*, which, if it were the homologue of the *pectoralis minor*, it would do. In the Sparrow-Hawk the trunk formed by the first and second of the cervical nerves, which join to form the plexus, gives off nerves to the *subscapularis*, the *teres major*, the *subclavius*, and the *pectoralis secundus*. The nerve to the last muscle is the first one given off from the front of the plexus, and it gives no branch to any other muscle. The external respiratory nerve, which passes down behind the brachial plexus and between the *serrati antici* and the ribs, has one root from the second factor of the plexus and one from the third. Its origin, therefore, and distribution, and its relation to the nerve to the *pectoralis secundus*, are close enough in resemblance to those of the human external respiratory to leave no reasonable doubt as to its homological identity with that nerve, and, by consequence, as to the identity of the nerve to the avian *pectoralis secundus* with the nerve to the mammalian *subclavius*. The nerve to the *pectoralis major* of the Sparrow-Hawk is given off from a point lower down in the plexus; and the three main trunks, which mainly make up the plexus, seem, as in the Alligator, all to give factors to it. It can scarcely be doubted that this nerve is the homologue of the two anterior thoracic nerves of the mammal.

If, thirdly, we are asked, Where is the second pectoral of the mammal to which the anterior thoracic nerves supply fibres as well as to the pectoralis? the answer furnishes us with our third argument, and runs thus:—In the young Sparrow-Hawk it is easy to divide the pectoral mass into two strata, the upper and deeper of which is much the feebler, but which is continued into a tendon continuous, indeed, with that of the *pectoralis magnus* on its deep surface, but prolonged upward, from its primary insertion into the inner tuberosity, very distinctly to the coracoid, being loosely connected with the tendons of the *biceps*, and ultimately attached (which the tendon of the *biceps* is not) to the *precoracoid epiphysis* of the clavicle. The description which I have given of the posterior layers of the great pectoral of the young bird is not, as far as I know, verifiable in the muscle, though it is in the tendon, of the adult. But it corresponds very closely with a description of the posterior layers of the great pectoral in the Common Rat, *Mus decumanus*; and it is difficult to see how it is possible to deny the homology of the upper fascicles of the posterior layer of the great pectoral in this animal with the *pectoralis minor* of Man. The nerve-trunk which thus supplies in the bird what I hold to be the homologue of the two *pectorales* of anthropotomy does, it is true, give off a nerve to one other muscle, viz. the *coraco-brachialis inferior*,

or *pectoralis tertius*, a muscle which arises from the posterior three-fifths of the outer and inferior edge of the coracoid, and is inserted into the inner tuberosity just inside the most mesially placed portion of the crateriform rim which it throws up round the mouth of the pneumatic inlet. But this nerve-trunk seems to me to be the homologue of the musculo-cutaneous nerve of anthropotomy, which supplies the *coraco-brachialis*, and is given off from the same outer cord of the plexus, whence the external anterior thoracic arises.

By studying the four figures appended to this paper, and the descriptions given of them, a better comprehension of the bearings of my position, that the *pectoralis secundus* of the bird is homologically identical with the epicoraco-humeral of the reptile, will be gained than could be conveyed by any disquisition, however lengthy, if unaccompanied by illustrations. The name "epicoraco-humeral" has been given by Mr. Mivart (Trans. Linn. Soc. vol. xxv. p. 383; Proc. Zool. Soc. June 27, 1867, p. 778) to a muscle found both in the *Echidna hystrix* and in the *Iguana tuberculata*, which arises from the preco-racoid and epicoracoid in the reptile, and from the epicoracoid in the reptile-like mammal, and is "inserted into the summit of the radial tuberosity between the inser-tions of the *pectoralis major* and *deltoid*." It was by recognizing in the shoulder-muscles of the Crocodile (fig. 3, *eh*) the homologue of this Saurian muscle, and by comparing it, when thus recognized, with the highly simplified *pectoralis secundus* (fig. 4, *eh*) of the Emu (*Dromaius Novæ Hollandiæ*), that I came to hold the view which I now put forth. The great reduction, already spoken of, which the sternal origin of the accipitrine *levator humeri* has undergone, as compared with the vast *pectoralis secundus* of the Gallinæ, prepares us somewhat for finding in the Emu a *pectoralis secundus* which, while it coincides in insertion, differs little in origin from the *epicoraco-humeral* of the Crocodile, except in the possession of a small head from the middle point of the sternum. The essential relations held by the muscles lettered *eh* in each of the two figures 3 & 4, to the surrounding parts, seem to be much the same in the intervals between their origin and insertions. The crocodilian muscle, however, receives a head from the visceral surface of the scapula, in compensation for the absence of the fibres which in the Emu arise from the coraco-clavicular membrane and sternum, but which in the Reptile appear to have been displaced by its great pectoral from its less-developed sternum. The *pectoralis secundus* of the Sparrow-Hawk, as already de-scribed, receives in a similar way an accession of fibres from the viscerad surface of the coracoid and sternum. It is possible that the fascicle *ei* in the Crocodile, if the homo-logue of a dislocated anterior segment of *rectus abdominis* may foreshadow the sternal prolongation of the avian *levator humeri*. But though this muscle seems exceedingly ready to build up extraneous elements into its own mass, it is perhaps more easy, with our knowledge of this muscle as it is to be described hereafter in the Frog, to con-ceive the *epicoraco-humeral* as encroaching from its own area on to that of the sternum, than to conceive of it as fusing with a "rectus thoracis," even though the *subclavius* of the Wombat does actually do this. Another point of difference is presented by the reten-tion in the Emu of a rudiment of the coracoidal pulley, which is not indicated in the Crocodilian shoulder-girdle, either as a nascent or as a retrograding structure. The *pec-*

toralis secundus of birds does not by any means invariably receive fibres from the coracoid; it does receive such an accession in the Sparrow-Hawk, but it does not do so in the Pigeon (*Columba livia*) for example; it may (as seen in great simplicity in the Emu and Apteryx) have a mesoscapular factor actually joined to its tendon, and inserted so as to be one in function with it, and it may be considered, therefore, to be essentially a sterno-præcoraco-scapular muscle. The sternal factor is lost in the Ostrich (*Struthio camelus*), and in the Rhea (*Rhea Americana*). Similarly the muscle figured at *eh*, fig. 3, from the Crocodile, is simply a "præcoraco-scapularis," with one head arising from the anterior surface of the expanse of bone constituted by the confluence of scapula and coracoid in front of the glenoid cavity, and with a second which joins the first on its mesial border as it passes round from the internal surface of the scapular, and is inserted into the outer tuberosity of the humerus, in close connexion with the upper edge of the great pectoral. In the descriptions given of this muscle, both in the Crocodile and in the *Ornithorhynchus*, it has been confounded with the *deltoid*. It is, however, shown by its innervation to be separate from it in nature; and its insertion lies between the insertions of the *deltoid* externally and that of the *pectoralis major* internally. This muscle has a single tendon in the Sparrow-Hawk, with three muscular heads converging upon it. In the Gallinaceous birds (*Gallus gallinaceus* and *Phasianus Colchicus*) the *levator-humeri* apparatus consists of three muscles, distinct both in origin and insertion, and innervated from two distinct sources. The largest of the three levator muscles of the Gallinaceous *humerus* has a very extensive origin from the sternum; but, as is the case in the Pigeon also, it has no distinct accession of fibres from the coracoid; but from the coracoid on its inner aspect, from the coraco-clavicular membrane, and from a small portion of the sternum a lesser *levator humeri* arises, which is inserted, after passing through the coraco-scapular canal and over the coracoid pulley, together with the tendon of the greater *levator*, between the point of insertion of this muscle (which is a little lower down, and more externally placed) and that of the great pectoral to its inner side. With the tendon of the greater pectoral *depressor* that of the lessor *levator* is very closely connected, as is that of the *epicoraco-humeral* of the Crocodile; and it is only the presence of the pulley arrangement which converts cooperation into antagonism. Thirdly, the small muscle which has been described as passing to the single *levator* tendon of the Sparrow-Hawk from the mesoscapula of that bird, has in the Gallinæ a larger size, a more extensive origin, and a separate insertion. It arises from the uppermost and innermost scrap of the scapula, *i. e.* from the "mesoscapula" of Parker, from the ligament which passes along the inner aspect of the coracoscapular canal from the mesoscapula to the *coracoid*, and from the innermost and uppermost scrap of the coracoid itself. Its tendon is inserted externally to that of the smaller *levator humeri*, internally and proximally to that of the great *levator*. In the common Goose this muscle, the "deltoides externus" of Meckel, is fused with a muscle of the same origin as the smaller *levator* of the Fowl; and we have thus an intermediate stage between the trifid insertion of the levator-apparatus of the Fowl and the single tendon of the Hawk. It will be obvious that the "deltoides externus" of the common Fowl corresponds, both as to origin and insertion, with the anterior or præglenoid head of the "epicoraco-

humeral" of the Crocodile, and that its smaller *levator humeri* corresponds as closely, *as to its insertion*, with the postscapular head of that reptilian muscle; and it might seem, therefore, that the larger *levator humeri* muscle of the Fowl remains without a separate homologue in the Reptile, were not this muscle innervated by the same *subclavius* nerve as the reptilian epicoraco-humeral, whilst the smaller *levator humeri* is, together with the *deltoides externus*, innervated from the circumflex. To an objector who denies the validity of this argument, and lays stress on the fact that the reptilian muscle has not the sternal factor of the avian *pectoralis secundus*, I reply, first, in the Emu a muscle very unmistakably homologous with the *præcoraco-scapularis* of the Crocodile possesses but a very small sternal factor; and, secondly, in the Ostrich (*Struthio camelus*), which also retains a *pectoralis secundus*, this sternal factor is aborted and lost. Stages of successive degradation from a highly specialized structural arrangement may well serve to guide our judgments in problems such as these, if it be true that the essential elements of a structure are the last which it loses so long as it retains any actual functional power at all. But, thirdly, lower types than even the scaly or loricate Reptile may have an *epicoraco-humeral* with a sternal factor. This is the case in the Frog, where the *epicoraco-humeral* (the "pars clavicularis deltoidei" of Ecker, 'Die Anatomie des Frosches,' p. 97) arises from what Mr. Parker (Shoulder-Girdle, pp. 79 and 80, and pl. v.) has shown to be the *præcoracoid* and the *omosternum*.

With this I close my case for proving that the *epicoraco-humeral* of the Reptile is the homologue of the *pectoralis s. levator humeri* of the Bird. It is not necessary for the acceptance of this conclusion that a person should accept also the Theory of Progressive Evolution. By speaking of organs as being "*homologically* identical," a person who is either averse to pronounce himself, or anxious to secure a dispassionate consideration from all parties, or both, may avoid pledging himself either to the theory which teaches that they are so by virtue of the "secret bond" of their "conformity to type," or to that which explains their oneness by a reference to "genetic affinity." As to which of the two theories a man will take for his guide in research, so far as any theory can serve for a guide in research, much will depend upon the idiosyncrasies, original or acquired, of individual minds. But though the theory may have only a subjective, the facts have an objective cogency.

With regard to the serial homologies of the fore and hind limbs, and, first, with regard to the representation of the ulna by the fibula and of the radius by the tibia, I have much pleasure in referring to Professor Pagenstecher's views, inasmuch as with many other of his conclusions I cannot bring myself to agree. But anybody who will look at his figures of the bones of the human arm and leg, placed side by side, each in the position which best shows their homotypical relationship, will have good reason for acquiescing in the view stated in the following sentence. In those figures we have the limb in either case so flexed as to have the angle formed at the knee and elbow respectively pointing upwards; the forearm is supinated, and the hand segment hyper-extended, so as to make almost a right angle with the long axis of the forearm. The ulna then lies and is directed a little posteriorly and dorsally as regards the radius; and the thumb and great toe, as also the little finger and the little toe, occupy, severally, corresponding posi-

tions. A very similar position, I may observe, is instinctively assumed by a man when he uses his pectoral muscles for the purpose for which quadrupeds ordinarily employ them, viz. for raising and supporting the trunk upon the fore limbs. And an observation of the position assumed by a man who puts himself into a quadrupedal posture for the purpose of drinking at a stream, or who raises himself by the help of his arms from a low seat by placing his hands on the table at which he is sitting, will illustrate the relations of the *extensor* and *flexor*, and of the inner and outer aspects of the two limbs, as well as the most detailed parallelization of the skeletal elements.

Secondly, a study of Mr. Parker's descriptions and histories of the shoulder-girdle will leave no doubt on the mind of any one, I apprehend, as to the serial homology of the *coracoid* with the *ischium*, and of the *præcoracoid* with the *os pubis*. The shoulder-girdles of the Frog and the Chelonians are especially instructive when compared with the pelvic girdle of the Crocodiles. Express utterances as to the relationship of the two sets of bones may be found in Mr. Parker's work 'On the Shoulder-Girdle and Sternum,' at pp. 7, 59, and 83.

Professor Huxley's view (which has been adopted by Mr. Mivart, and a similar one to which, I am informed by Professor Turner, of Edinburgh, was entertained by his predecessor Professor Goodsir), as to the homotypical relationship of the *subscapularis* and *teres major*, not to the *iliacus* and *psoas*, but to the middle and smallest *gluteus*, is a third point for discussion, and one which does not admit of being decided quite so cursorily as the two I have already glanced at. For the acceptance of this apparent paradox, it is necessary first to accept the principle that the true homology of a muscle is to be determined by its insertion (see Mivart, Trans. Linn. Soc. vol. xxv. p. 398 and 400). To this principle I should give a general assent, without forgetting that we may find exceptions to it, such as the insertion of the *pectoralis major* of the Sparrow-Hawk into both tuberosities of the humerus, such as the occasional insertion, in the way of corollary to this first exception, of the *pectoralis minor* into the outer tuberosity of that bone, or such, thirdly, as the insertion of the *psoas* of the Crocodile on the outer, while the *iliacus* is inserted on the inner side of the femur. In these cases, however, rudiments at least of the primitive insertion in the shape of aponeurotic bands will ordinarily be left remaining, as if to indicate that it has been, so to say, not by an arbitrary transference, but by a gradual lateral extension that the alteration of the point of attachment has been effected: and the essential character of a muscle may be considered to be as little affected by these transgressions of its ordinary limits laterally, as the essential character of a muscle which is ordinarily inserted into the proximal segment of a limb is considered to be affected by its occasional prolongation into a distal segment, by fascia or aponeurosis, which may finally be specialized into a tendon. There are, however, three sets of anatomical facts to which I would draw attention, as they seem to me to make the denial of the homotypical relation of the *iliacus* and *subscapularis*, and the ranking of the latter muscle with the *glutei*, less of a stumblingblock. First, there can be no reasonable doubt that the essential character of the muscle I have called "epicoraco-humeral" in the Crocodile, is determined by its innervation and by the insertion or wedging in of its tendon on the outer surface of the humerus between those of the *pectoralis major* and *deltoid*. Yet,

as is seen by fig. 3, this muscle receives a head from a surface of the scapula as completely turned *viscerad* as the iliacal surface of the ilium ever is. The origin of the slender *epicoraco-humeral* of the Chamæleon is limited to the external surface of its *coracoid* and *præcoracoid*; but its *supraspinatus*, if we may so style the muscle which comes next in order from below upwards after the deltoid, does receive just such a factor from the visceral surface of the scapula as does the *epicoraco-humeral* of the Crocodile. This muscular belly having the stem of the scapula placed exteriorly to it reminds one forcibly of the relation held by the os ilii to the *iliacus*; but the lesson which it teaches does not depend upon such resemblances as this, but upon the retention to some extent by the Chamæleon of the primitive rod-like character of the scapula, which makes it easier for us to see how it may rotate any one of its surfaces, when developed like the fluting on a column, into several different bearings in different animals. It is easier for us to understand how a muscle can wrap its origin round and about the various aspects of a cylindriform, than it is for us to conceive of similar indifferentism in the various surfaces of a many-facetted bone; and upon the conquering of this difficulty depends our power of homologizing the *spinati* with the *iliacus* *.

A second argument in the same direction presents itself from another quarter, that of innervation. The homologies of the nerves of the two limbs are much masked by the *iliopsoas* having carried with it in front of the pubic arch the anterior crural nerve—as also by the separation from this nerve of the peroneal trunk, which is seen, by its distribution, to correspond mainly with those elements of the musculo-spiral nerve which are distributed in the distal segments of the upper limb. But if we place side by side, with diagrams of the nerves of the two limbs, such as those given in plates iii. and iv. of Mr. Flower's "Diagrams," tables which give the spinal nerves to which the nerves of the limbs are ultimately traceable, we see that the suprascapular nerves correspond with the nerves to the *iliacus*, and the nerve to the *subclavius* with the *obturator*'s branch to the inner head of the *pectineus*. The branch from the anterior crural, or from its internal cutaneous division, to the outer head of the *pectineus* answers to the circumflex, whilst the muscle, by having these two sources of nerve-supply, corresponds, even curiously, with the two *levatores humeri* of the Fowl, and the *glutei*-nerves and muscles are then left as homologues of the subscapular, *teres major*, and *latissimus dorsi*.

Thirdly, there can be little doubt that the *coraco-brachiales*, *superior* and *inferior*, of Meckel (no. xvi. and xvii. of Schoepss), in the bird correspond, not only to the *adductores* in the lower limb, but also to the *obturator internus* and *externus*, arising as they do, the former from the visceral, and the latter from the external surface of the parts homologous with the points of origin of the two *obturatores*. Now, close as is the relation between the tendons of the smaller *glutei* and the *obturatores* at the external or larger trochanter of the human femur, it is not at all more intimate than that which subsists between the tendons of the *coraco-brachiales* and those of the *subscapularis* and *teres major* on the lesser tuberosity, as represented by the crateriform rim of the pneumatic foramen. If the

* The so-called "third or deep head" of the *Iliopsoas* (see Henle, Handbuch Anat. Mensch. i. 3. 242), the *musculus iliacus internus minor* of Luschka (Anat. Mensch. ii. 2. 131) is described by the latter anatomist as lying quite exteriorly to the pelvic cavity. It comes thus to correspond most instructively with a *teres minor*. Similarly helpful is the large size of the facet of origin of the *teres major* in such an animal as *Ursus maritimus*.

superior *coraco-brachialis*, the origin of which is described in my account of the muscles of the Sparrow-Hawk, be the homologue of the *obturator internus*, it is difficult to deny the homology of the *subscapularis* (with the tendon of which its tendon fuses) with the *gluteus medius*, which holds so much the same relation by its tendon to the *obturator internus*.

Leaving now the subject of the homology of the *subscapularis* and *teres major* with the *glutei*, I may refer to the nerve-supply of the *teres minor* from the same nerve, the circumflex, which supplies the *deltoid*, as showing that this muscle is really but a divarication of the *deltoid* posteriorly, as a similar line of argument shows the *tensor fasciæ femoris* to be of the *gluteus medius*. The difficulty, therefore, as to the nomenclature of the muscle, which in Saurians and the monotrematous Echidna (see Mivart, Trans. Linn. Soc. vol. xxv. p. 384, and Proc. Zool. Soc. June 1867, p. 778; Stannius, Handbuch der Zootomie, ii. p. 126) has been sometimes called "teres minor" and sometimes "a second part of the deltoid," may be met by saying that the posterior factor of the "*deltoid*" is not, in these lower animals, differentiated into a superficially placed "*deltoid*" and a deeper lying "*teres minor*." There is ordinarily no *infraspinatus* differentiated from a *supraspinatus* in either bird, saurian, or Crocodile. But both these latter classes possess the muscle which, with the origin of the *teres minor*, has the insertion of the *teres major*, and is called "subscapulo-humeral" by Macalister (Proceedings Royal Irish Academy, December 1867) and Wood (Proceedings Royal Society, May 23, 1867, p. 534), "infraspinatus secundus" by Professor Haughton, "teres major" by Stannius (Zootomie, ii. p. 128, 2nd ed.), and, finally, "teres minor" by many anatomists, though incorrectly, if the insertion is to determine the name and nature of a muscle rather than its origin. Meckel (Vergleichend. Anatomie, iii. p. 512) uses this last nomenclature, speaking of a muscle with the origin and insertion specified as a "teres minor," and stating that it is found in the Horse, in Ruminants, in the Aï, and in the Mole. A few birds possess this accessory *teres major*. In the common Fowl it arises from the outer surface of the scapula, a little way anteriorly to the downward-growing process, so well marked in the Gallinæ and in the Dodo, which receives the tendon of the anterior portion of the *serratus anticus*. It is inserted on the posterior lip of the pneumatic foramen, a point serially homologous with that of the insertion of the smaller *glutei* of human anatomy.

This muscle is not possessed by the Common Pigeon, but it is found in the Common Buzzard and Sparrow-Hawk, and in the Goose. The *teres major* proper is of very large size in ordinary birds; it is present in the Crocodile, but absent in saurians. It is not inserted with the *latissimus dorsi* in the Sparrow-Hawk, but passes to the anterior lip of the entrance to the pneumatic foramen, to a point just opposite to that of the insertion of the accessory *teres major*.

In birds there is no præscapular region (Parker, Shoulder-Girdle, p. 143), and consequently no *supraspinatus*. Indeed, as the *supraspinatus* of Meckel, *l. c.* p. 313 (no. xv. Schoepss), receives its nerve-supply from the circumflex, and must be looked upon as a part of the deltoid, birds would appear to have no "suprascapular" muscles at all, unless we may consider the deeper fibres of the præglenoid head of the *levator humeri* in the Emu and Apteryx to represent such a muscle; for there is such a muscle in the

Crocodile, underneath the epicoraco-humeral and the deltoid, and supplied by the same nerve as the former of these muscles. It takes origin from the triangular surface (*ss*, fig. 1) intercepted between the deltoid ridge, *d*, and the scapulo-coracoid fissure, and it is inserted just where the pectoral ridge sinks into the articular head of the humerus, proximally to the tendon of the *teres minor*. The suprascapular muscle is not ordinarily differentiated in reptiles into an *infra-* and *supraspinatus*. But in a Gecko, *Platydactylus*, sp. ?, I have observed it to take origin from the coracoid, as well as from the scapular region of the shoulder-girdle; and by doing this, it has brought itself by origin, as it is often by innervation, into close correspondence with the *coraco-brachiales* muscles, and, serially, with the *iliacus* of reptiles.

The muscle seen in fig. 4, intercepted between the tendon of the *biceps* and that of the *pectoralis secundus* is called "deltoides internus" by Meckel; it is, however, obviously homologous with an upper segment of the *coraco-brachialis*, as seen in fig. 3 from the Crocodile, and with the "short coraco-brachialis" or "rotator humeri" of Wood (Cambridge Journal of Anatomy and Physiology, Nov. 1866, p. 49).

The muscle described by Mr. Mivart in the *Iguana tuberculata*, under the name of "gracilis," and stated by him to "represent possibly the *gracilis* of mammals," seems to me to be a serial homologue, which I have not met with elsewhere, of the *pectoralis major*. It arises from "the ischiatic symphysis" (where, in the saurians, an ossific nodule, the *os cloacæ*, may not rarely be found placed mesially, as though representing a sternum), and "from the long tendinous arch which passes from the front of the acetabulum, round behind the pubic spine, back to the symphysis just mentioned." This latter origin seems to me to correspond with the interclavicular and clavicular origin of the pectoral, as seen in some of the Sauropsida, and, as far as regards the clavicle, in mammals. Its insertion into the peroneal side of the head of the tibia seems to me to be paralleled by the insertion of the the *pecto-antebrachial* of certain mammals, *e. g.* the Cat (see Straus-Dürckheim, vol. ii. p. 352, pl. vii. figs. 13, 15). Mr. Mivart, by lettering his tibial *adductor* S, may be understood, perhaps, to mean that he considers this muscle homologous with the *sartorius* of anthropotomy; and in this identification I should coincide. But the *gracilis*, which he seems to think may perhaps be represented by the muscle I suppose to be homologous with the *pectoralis major*, I think must be represented by a head which the tibial *adductor* in the *Iguana tuberculata* examined by me received from the symphysis of the ischia.

Mr. Mivart's *ilio-peroneal* seems to me to have its serial homologue in the muscle which, in many mammals, passes from the posterior vertebral angle of the scapula down to the olecranon, and which seems to be a divarication of the more commonly found "dorso-épitrochlien." As this muscle is clearly one of the series made up of the *biceps*, *semimembranosus*, and *semitendinosus*, which, like itself, take origin, in Crocodilidæ, from the ilium, it may be suggested that in the muscle just mentioned, as found in certain mammals, among which I may specify the Marten (*Mustela martes*), may be contained the homologues of the *biceps*, *semimembranosus*, and *semitendinosus*, as well as the *ilio-peroneal* of the lower limb. This great increase of the number of the muscles of the lower, as compared with that of their homologues in their upper limb, is illustrated also

by the great excess which the number made up by the *adductores* and the *obturatores* shows when compared with that of their homotypes the *coraco-brachiales*. It furnishes us with a fresh illustration of the principle laid down by Mr. Parker (Shoulder-Girdle, p. 7, note), to the effect that "the hip-girdle is always, in the higher classes, more complete as to mere mass, and lower in type morphologically, than the shoulder-girdle."

Tabular View of Muscular Homologies suggested in this Paper.

Name of Muscle in Mammal.	Homologue in Upper Extremity of Bird.	Homologue in Upper Extremity of Reptile.	Serial Homologue.
Pectoralis major.	Ditto.	Ditto.	"Gracilis" of Mivart, as described in *Iguana*, P. Z. S. 1867.
Pectoralis minor. Essentially the upper or anteriorly inserted fascicles of the deep layers of *pectoralis major.*	Ditto.	Fascicle lettered *ei* in fig. 3?	?
Subclavius. In mammals only is it of subordinate importance to the *spinati.*	*Pectoralis secundus s. levator humeri.*	*Epicoraco-humeral* of Mivart, as described in *Echidna* and *Iguana*, l. c. Amphibian *pars clavicularis deltoidei* as described by Ecker, *cleido-humeralis* of Pfeiffer.	Inner and deeper head of *pectineus*, supplied by obturator nerve.
Coraco-brachialis brevis s. rotator humeri of Wood.	*Deltoides inferior* of Meckel. No. xx. of Schoepss, Meckel's Archiv, 1829.	Upper part of *coraco-brachialis* lying superiorly to tendon of *biceps.*	Upper fascicles of *obturator externus.*
Coraco-brachialis medius. *Coraco-brachialis longus.*	*Pectoralis tertius s. coraco-brachialis inferior.* No. xvi. Schoepss, *l. c.*	Middle and longer portions of anterior *coraco-brachialis.*	Rest of *obturator externus* and adductors.
Deep portions of *coraco-brachialis*, in Monotreme. (See Mivart, p. 385, Linn. Soc. Trans. vol. xxv.)	*Coraco-brachialis superior.* No. xvii. Schoepss suggested as homologue by Mivart, *l. c.*	Ditto.	*Obturator internus.* This muscle is never supplied by the obturator nerve.
Deltoid.	Represented in birds by the *deltoides externus* of Meckel, no. xix. Schoepss, by the *deltoides superior* of Meckel, no. xviii. of Schoepss, and by the smaller *levator humeri* of the Fowl.	Deltoid.	Outer head of *pectineus*, supplied by anterior crural nerve or its internal cutaneous branch.
Infraspinatus, and *supraspinatus.*	Not found in birds as differentiated slips.	*Suprascapularis*, "infraspinatus," Mivart.	*Iliacus*, exclusively of part specified below.
Teres minor. Essentially a deep portion of posterior part of deltoid.	Not differentiated in birds, except Emu and other Ratitæ?	Differentiated in Crocodile and Chamæleon.	*Musculus iliacus internus minor* of Luschka, Anat. Mensch. ii. 2. 131.
Scapulo-humeral. Essentially a part either of *subscapularis* or *teres major.*	Present in Fowl, Goose, Sparrow-Hawk, Buzzard. Absent in Pigeon.	Present in Crocodile. Absent as a differentiated slip in some saurians.	*Musculus scansorius.*
Teres major.	Very large in birds.	Present in Crocodile. Absent as differentiated slip in some saurians, as Chamæleon.	*Tensor fasciæ femoris.*

Table (*continued*).

Name of Muscle in Mammal.	Homologue in Upper Extremity of Bird.	Homologue in Upper Extremity of Reptile.	Serial Homologue.
Pyriformis.			In *Macropus major* a thin muscular slip arises from superior border of scapula near the origin of *omohyoid*. It passes down over the tendon of the *subscapularis*, with which muscle it is closely connected for an inch and a half, and it is also attached to the tendon of the *biceps* as it glides over the inner tuberosity of the humerus. It is inserted on the inner side of humerus above but close to the tendon of the *teres major*, overlying and giving fibres to the inner head of the *triceps*. This muscle corresponds with the iliac head of the *pyriformis*. The *acromio-trachelian* corresponds with its sacral head.
External and internal intercostal of anterior intercostal space.	"*Subclavius*" of birds.	*Subclavius* of reptiles.	External and internal intercostal muscles.
Biceps femoris. *Semimembranosus.* *Semitendinosus.*			Muscle arising from posterior vertebral angle of scapula, and passing down to olecranon. Lettered + t. in Cuvier and Laurillard's 'Planches de Myologie,' pls. 100, 104, 108.

DESCRIPTION OF PLATE XLVII.

Fig. 1. Scapulo-coracoid arch of Crocodile (*Crocodilus vulgaris*).

sc. Scapula.

cr. Coracoid.

gl. Glenoid cavity.

bc. Facet of origin of biceps. Round this portion of the coracoid the head of the "epicoraco-humeral" muscle which comes from the inner surface of the scapula winds.

pcr. Præcoracoid. The surface whence the coracoid head of the "epicoraco-humeral" muscle arises extends from the point lettered *pcr* up to the line of fissure between scapula and coracoid, and a little beyond it.

d. Ridge on scapula, giving origin to deltoid.

tc. Facet of origin of triceps.

ss. Surface of origin of supraspinatus.

cr f. Coracoid foramen.

Fig. 2. Scapulo-coracoid arch of Emu (*Dromaius Novæ Hollandiæ*). Adult.

sc. Scapula.

cr. Coracoid.

gl. Glenoid.

pcr. Præcoracoid.

cla. Line of clavicular abutment on scapula.

Between the points *pcr* and *gl*, and below *cla*, lies the præglenoid expanse, made up by factors both from scapula and coracoid. From this expanse the coracoid head of the epicoraco-humeral muscle takes origin. The deltoid takes origin from the scapula immediately above and behind the line *cla*.

Fig. 3. Muscles in connexion with the scapulo-coracoid arch and upper extremity of Crocodile (*Crocodilus biporcatus*). The same arrangement has been noted in *Alligator lucius*, with scarcely any differences.

p m. Pectoralis major. The muscle has been divided, and its origin from the sternum and interclavicle turned mesially, and its tendon of insertion into the greater tuberosity of the humerus turned outwards. *p m'*, tendon of pectoralis major.

eh. "Epicoraco-humeral" of Mivart (Trans. Linn. Soc. vol. xxv. 1866, p. 383), a bicipital muscle; its inner head winds round the coracoid face of the præglenoid expanse, to take origin from the visceral surface of the scapula; its outer head arises from the præcoracoid, and, to a small extent, from the præscapular portion of the præglenoid expanse, where it is in close relation with the deltoid. The inner of these two heads is intimately connected at its insertion with that of the pectoralis major, and, together with the tendon from the other head, occupies on the humerus a position between that of the tendon of the deltoid externally and inferiorly and that of the pectoralis major internally and inferiorly. The insertion of the omohyoid corresponds with the origin of the præglenoid head of the epicoraco-humeral; and the fibres of the two muscles are, to some slight extent, continuous with each other, at least in young specimens.

e i. Muscular fascicle which arises from second sternocostal cartilage in the same series as the external oblique and intercostals, but which may also be looked upon as homologous with an anterior segment of the "rectus abdominis," which is often not distinguishable from the former of these muscles. It ends in a delicate tendon, which loses itself, along the coracoid groove, in the sternum and the origin of the pectoralis major. The rectus abdominis in many ordinary mammals has an insertion into the first rib (see Professor Turner, 'Cambridge Journal of Anatomy and Physiology,' May 1868, p. 393), from which the ordinary mammalian subclavius arises; and in the order Monotremata it has, in both species of *Echidna* and in the *Ornithorhynchus*, an insertion into the coracoid at no great distance from the area of origin of their epicoraco-humeral, which I hold to be the homologue of the subclavius of other mammals. The prolongation of the tendon of this muscular fascicle (*ei*) may be considered to be due to the withdrawal of the Crocodile's epicoraco-humeral to the upper end of the coracoid. Finally, as the rectus is often fused with the pectoral, we may regard this fascicle as a nascent pectoralis minor.

e o. Muscular fascicle arising from the tip of the freely ending cartilage of the first thoracic rib (a point homologous with the points of origin of the several fascicles of the external oblique), and passing downwards and forwards to end in an aponeurosis attached mesially to the sternum and continuous with that of the external obliqne. By contracting a close adhesion to the fibres of the anterior prolongation of the rectus abdominis instead of passing freely over them, as here, this muscular slip may, in other animals, as *e.g. Cynocephalus hamadryas*, assume the appearance of an outer head to this anterior prolongation. But its true character of homology with the fascicles of the external oblique is seen as plainly in the Guineapig (*Cavia aperia*) and the Aardvark (*Orycteropus Capensis*), and, according to Meckel (Vergleich. Anatomie, p. 454), in the Raccoon (*Procyon lotor*) and in the Hedgehog (*Erinaceus Europæus*), as it is here. In the Wombat (*Phascolomys wombat*) the true relations of this fascicle are very clearly seen; and a fascicle, obviously homologous with the one lettered *e i* in the Crocodile, passes from under it to join the subclavius arising from the first rib. This latter muscle arises, thick and fleshy, from the first rib in the Wombat, and is inserted into the outer end of the clavicle, and, by means of the fascia covering the supraspinatus muscle, into the whole length of the spine of the scapula. Before its insertion it is joined by a fine tendon from a delicate muscular belly, arising from the sixth costal cartilage, and homologous with the muscular fasciculus figured here at *e i*. Over this fascicle, which might be described in the Wombat as a second head of the subclavius, there passes inwards from the outer part of the first rib a muscular fasciculus, homologous with the

one here figured in the Crocodile as *e o*, to end in a broad tendinous aponeurosis over the sternum, opposite the third and fourth costal cartilages. It is probable, on the whole, that this fascicle *e o* may be really the homologue of the muscular slip which is called "rectus thoracis" by Professor Turner, *l. c.*, and which, as figured and described by him, appears to have a tendency to be produced obliquely inwards towards the sternum. (See 'Cambridge Journal of Anatomy and Physiology,' May 1868, pp. 393, 394, *ibique citata*.)

scl. Subclavius or triangularis sterni muscle, the "pectoralis secundus" of Haughton, and "costo-coracoid" of Mivart (Proc. Zool. Soc. June 1867, p. 776). Its superficial layer arises from the free cartilage of the second thoracic rib, and from the intermediate and sternal elements of the third and fourth thoracic ribs, and is inserted along the posterior edge of the coracoid. This muscle is obviously homologous with the similarly stratified muscle of similar origin and insertion in the bird, which is ordinarily called "subclavius," *e. g.* by Schöpss (Meckel's Archiv, 1829); but it cannot be homologous with the pectoralis secundus or levator humeri of the bird, inasmuch as the two muscles coexist with each other there. The same reasoning shows that it is not homologous with a pectoralis minor, though the slip which, in *Alligator lucius*, it gives to the muscle *e i* may be so in part.

cb. Coraco-brachialis, arising from anterior four-fifths of humeral edge of coracoid.

bc. Tendon of biceps, passing to be inserted on cephalic edge of coracoid.

Fig. 4. Muscles in connexion with the scapulo-coracoid arch and upper extremity of the Emu, *Dromaius Novæ Hollandiæ*.

p m. Pectoralis major. This muscle has a few fibres of origin in an aponeurosis playing over the lower and outer angle of the coracoid; it arises also from the three anterior sternal ribs, and from a triangular space on the sternum, lying between the two other points of origin. It is inserted into the great tuberosity of the humerus by a tendon attached distally and internally to those of the epicoraco-humeral and deltoid.

ch. Epicoraco-humeral muscle. It arises from the mesial point of the sternum or "rostrum" of the bone, from the coraco-clavicular membrane extending from the sternal rostrum up to the clavicle, and, thirdly, from an irregularly quadrangular præglenoid headland, which, as verified in a young specimen, is constituted by scapula as well as by coracoid. It is inserted into the humerus a little proximally and internally to the deltoid, and superficially to the coraco-brachialis. It is obviously the homologue of the pectoralis secundus s. levator humeri of ordinary birds. (See Meckel on Anatomy of Cassowary, Meckel's Archiv, 1830, p. 255. 5.)

bc. Tendon of biceps inserted into the humeral, and not, as in the Crocodile, into the cephalic edge of the coracoid. Between this tendon and that of the epicoraco-humeral or pectoralis secundus is seen the coraco-brachialis muscle, much reduced in size as compared with its homologue in the Crocodile. It has lost all the portion which arose mesially to the insertion of the biceps, and which Meckel called "coraco-brachialis inferior s. pectoralis tertius," and Schöpss *l. c.* "pectoralis medius." Neither Schoepss nor Meckel seems (as far as the name "deltoides inferior" can show, which they have given to the small muscle arising in ordinary birds from the lip of the coracoid underneath the tendon of the biceps, and inserted into the upper part of the great pectoral tuberosity) to have recognized its homology with the upper part of the coraco-brachialis muscle of the Crocodile and the *coraco-brachialis brevis s. rotator humeri* (Wood) of mammals. The only difference, however, between the muscle which Meckel and Schoepss call "deltoides inferior" in the common Fowl and that which I have called in the Emu "coraco-brachialis" is, that the larger biceps of the former animal has overlaid and stunted the muscle which the smaller biceps of the Emu has allowed to retain its reptilian proportions superiorly to its own insertion.

d. Deltoid, overlying and concealing from view a *teres minor* not found ordinarily in birds.

tc. Triceps.

Postscript, Dec. 11, 1868.

Several memoirs bearing more or less directly upon the subjects treated of in this paper have appeared, or at least come into my hands, subsequently to June 14th, 1868. First among them I may mention the paper on "Variations in Human Myology," which was read June 18th, 1868, before the Royal Society, by John Wood, Esq., F.R.C.S. In this paper, as published in the Royal Society's Proceedings, vol. xvi. no. 104, will be found an excellent figure of that common modification of the *pectoralis minor* which converts it into a more or less perfect *levator humeri*, so far as function is concerned. But that it was not a morphological equivalent of the *pectoralis secundus* of the bird would have been shown, I apprehend, first, by its relation to the costo-coracoid membrane, and, secondly, by its innervation. Meckel, in his 'Vergleichende Anatomie,' iii. p. 318, speculates as to whether the bird's "pectoralis secundus" is to be regarded as a divarication of the great pectoral, or as a specialization of a part of the deltoid. Now, as I hold that the *pectoralis minor* is essentially a part of the *pectoralis major*, I should say that Mr. Wood's figure shows that *a levator humeri may* be formed in the former of these two ways; and that such a muscle *may* be formed in the second of these two ways also is shown by the history I have given, pp. 618, 619 of this paper, of the smaller *levator humeri* in the Fowl. But that the ordinary *levator humeri, s. pectoralis secundus*, of birds, which coexists with the smaller *levator* in the Fowl, corresponds, *as a matter of fact*, to the epicoraco-humeral of the Reptile and the *subclavius* of the Mammal, is shown by the history of its relations to surrounding parts, by its nerve-supply, and by the history of the development of the great pectoral. Nor does functional correspondence enable us to argue to morphological identity here more than anywhere else.

Secondly, Professor Goodsir's 'Anatomical Memoirs' have, since last June, been published under the able editorship of his successor, Professor Turner; and in the first volume, at p. 452, may be found an exposition of the views of the late great anatomist, alluded to at p. 620 of this paper, as to the "morphology of the muscles of the limbs." With reference to this paper, I would remark that it seems incorrect to class the *obturator internus* with the *subscapularis*, because in many birds there coexists, with a *subscapularis*, a "coraco-brachialis superior" (no. xvii. Schoepss), which takes origin from the visceral surface of the coracoid bone and from the same aspect of the coraco-clavicular membrane. The tendon of this muscle may fuse with that of the *subscapularis*; and the bicipital muscle thus formed may receive its nerve-supply from a single nerve: but this nerve has never been observed by me to be the same as that which supplies the "coraco-brachialis inferior" (no. xvi. Schoepss), any more than the nerve of the *obturator internus* is ever the same as that of the *obturator externus*. But it is plain that the *coraco-brachialis superior* must represent the *obturator internus*, and the *subscapularis* the gluteal muscle, which, as mentioned at pp. 621, 622 of this paper, is so closely united with that obturator.

Neither can I coincide with the late Edinburgh Professor's comparison of the *teres minor* and *infraspinatus* to the *gluteus minimus* and *medius*—first, because I cannot but think that the *musculus iliacus internus minor* (see pp. 622–624 *supra*) is homologous with the *teres minor*, and, secondly, because I cannot consider the innervation of these

upper-limb muscles to be in any way homologous with that of the *glutei*. The *spinati* and *glutei* do, it is true, resemble each other in attaining their greatest development in mammals; and the so-called "*gluteus maximus*" and "*medius*" of the Crocodilidæ (of Dr. Hair, 'Cambridge Journal of Anatomy and Physiology,' Nov. 1867) may be seen, by their innervation from the anterior crural, not to correspond to the similarly named muscles of mammals. But concomitant variation within the limits of a single class does not make two sets of muscles, with essentially different insertion and innervation, to be serially homologous.

Few anatomists would now deny that the os pubis is the homologue, not of the clavicle, but of the præcoracoid; but though I have myself accepted the comparison of the *iliacus* to the *spinati*, I should not so positively dissent from Professor Goodsir's comparison of it to the deltoid as I do from his other comparisons here specified.

But I may be permitted, perhaps, to say that the *recti abdominis* can scarcely be considered to form, as Professor Goodsir ranks them as forming, a class apart from the external and internal *obliqui*; for the arrangement of these muscles, as seen, for example, in the common Fowl and the common Pigeon severally, seems to me to show that the *rectus abdominis* may be considered to be a specialization in one animal of one, and in another of the other of these muscles. Neither is evidence wanting to show that the *recti abdominis* should, instead of being placed in a class by themselves, have the *pectorales* as well as the *obliqui* ranked with them*.

Thirdly, a copiously illustrated memoir on the subject of this paper, "Die Muskeln der vorderen Extremitäten der Reptilien und Vögel," by Dr. Rüdinger, of Munich, has come into my hands quite recently. In it, however, I can find no views enunciated as to the homology of that most distinctively avian specialization the *pectoralis secundus*. At p. 105, however, of this memoir I find a statement as to the muscles of saurians which confirms the view I had previously formed as to the homology of the muscular bellies which pass in certain animals (see p. 623) from the scapula to the forearm with the hamstring muscles of the lower limb. His words run thus:—"Nur erhebt sich zwischen dem lateralen Kopfe (des Triceps) und dem Deltoideus ein vom Schulterblatt *besonderer länglicher Muskel*, welcher da, wo gewöhnlich das Ligamentum intermusculare externum angebracht ist, nach unten gelangt, an der Beugeseite des Vorderarms Verstärkung erhält, und, theilweise mit der Aponeurose der am untern Ende des Humerus entspringenden Muskeln zusammenhangend, seinen Ansatz mit einer dünnen runden Sehne an der Beugeseite des Radius findet."

Finally, I should add that I have strengthened the conclusions which I laid before the Linnean Society in June last by employing, as suggested to me at the meeting by Dr. Boycott, the evidence which may be drawn from the facts of innervation. But as this line of evidence has not, so far as I know, been touched upon in any other memoir upon this subject, I have not thought it necessary to keep the particular arguments which belong to it apart from the rest of the text.

* See Mivart, Proc. Zool. Soc. June 27, 1867, p. 776. Meckel, Vergleich. Anatomie, iii. pp. 155, 197. Ecker, Anatom. Frosches. p. 95. See also, at page 626 of this memoir, the description of Fig. 3, *e i*.

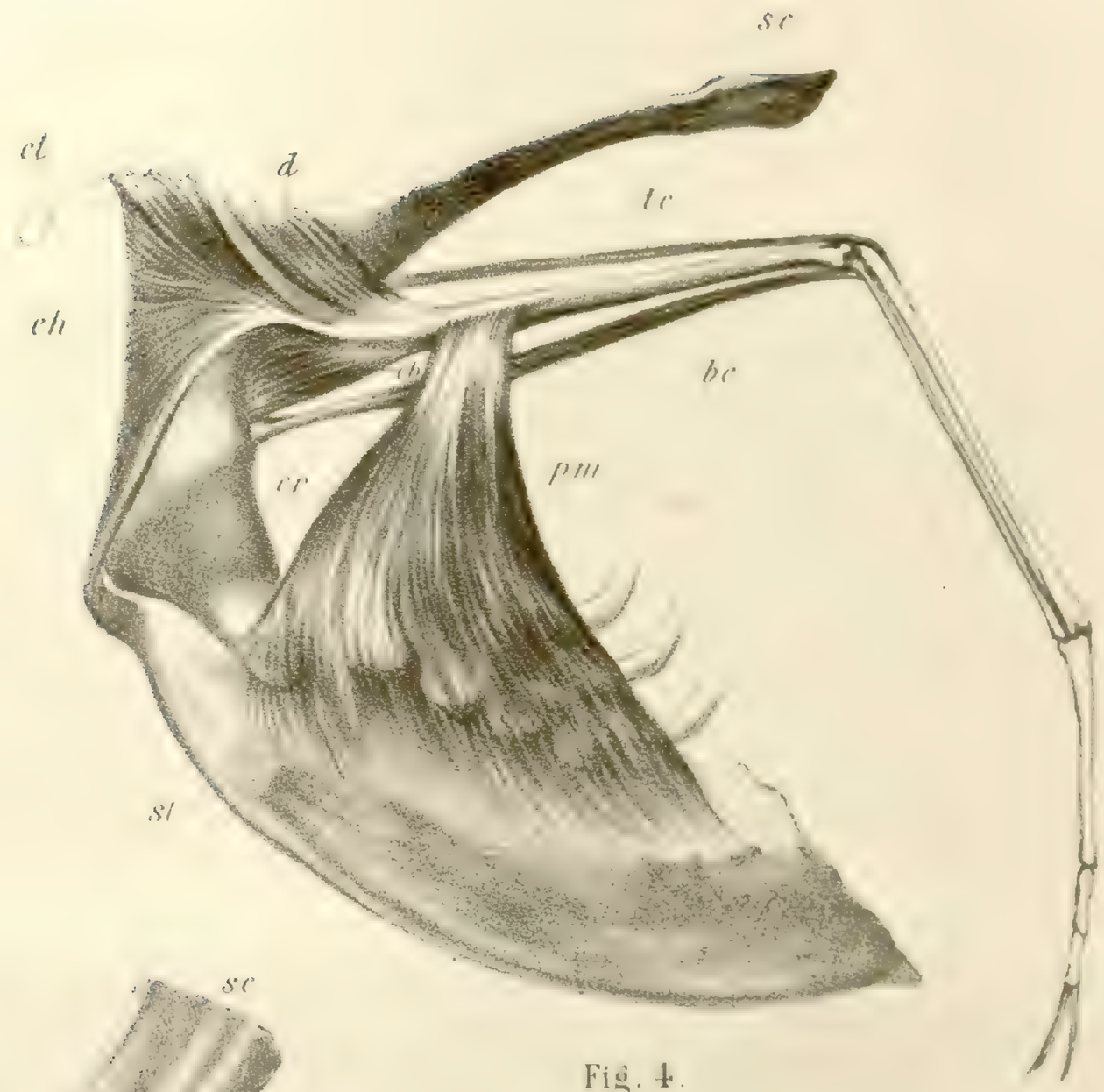

Fig. 4.

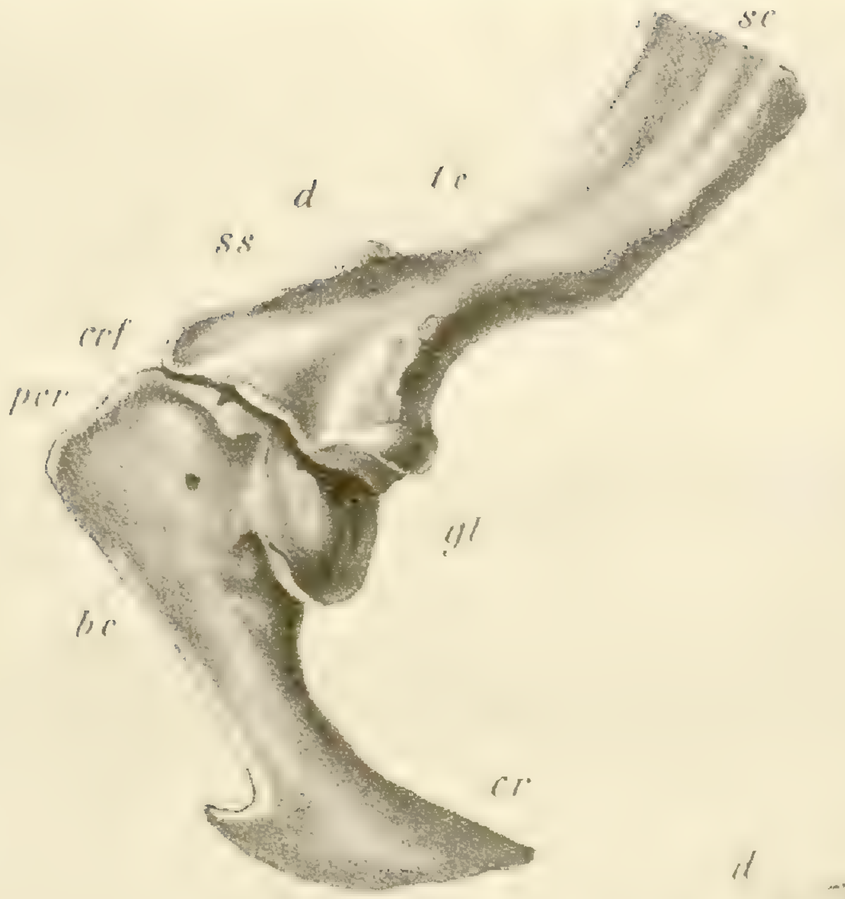

Fig. 1.

Fig. 2

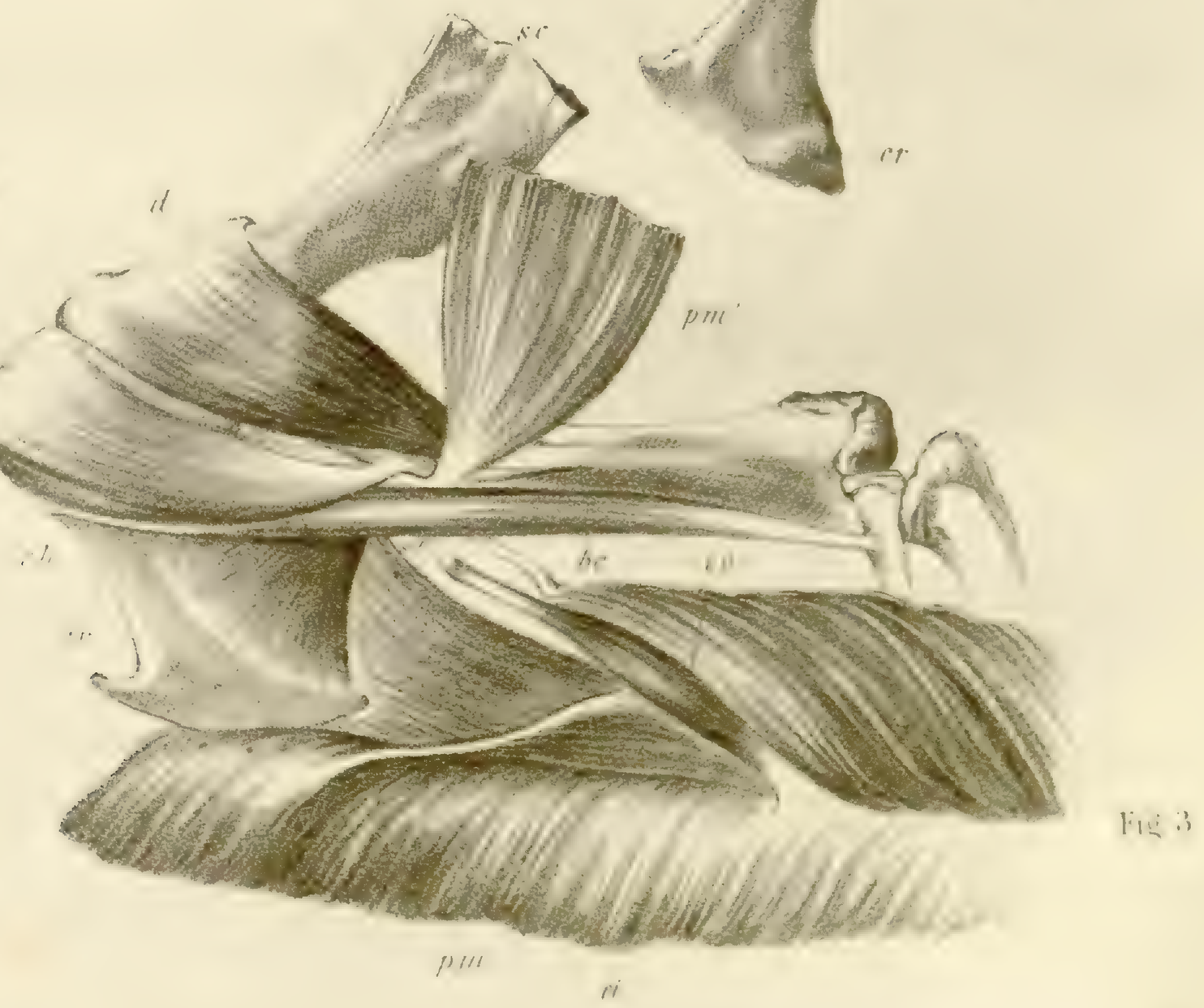

Fig. 3

E.M Williams, lith. G Crozier, del.

Vincent Brooks Day & Son imp

XIV. *A Contribution to the Knowledge of the Lower Annelids.*

By E. Ray Lankester, *Esq.* *Communicated by* George Busk, *Esq.*, *Sec. L.S.*

(Plates XLVIII. & XLIX.)

Read December 5th, 1867.

Contents.

I. The anatomy and fissiparous reproduction of the asexual *Chætogaster limnæi*, v. Bär.
II. Remarks on *Chætogaster niveus*, Ehr.
III. On *Æolosoma quaternarium*, Ehr., and its young form.
IV. Relations of *Chætogaster* and *Æolosoma* to other low Annelida.

I. *The Anatomy and Fissiparous Reproduction of* Chætogaster limnæi, *von Bär.*

History.—The minute worm which is found parasitic on specimens of *Limnæus* and *Planorbis*, and which is remarkable as being at present the only recorded instance of a parasitic Chætopodous Annelid, has been referred to under various specific names by different writers. Owing to imperfect description it has become quite impossible to recognize clearly what species some of the earlier authors meant to indicate by their names, and we have now the following list from which to choose—*Nais vermicularis* of Müller, *Chætogaster limnæi* of von Bär, *Nais diaphana* and *N. diastropha* of Gruithuisen, *Ch. furcatus* and *Ch. niveus* of Ehrenberg, *Mutzia heterodactyla* of Vogt, *Chætogaster Mülleri* of D'Udekem. Of these, it appears that Müller probably included two species under his name *N. vermicularis*, whilst von Bär's species, *Ch. limnæi*, is distinct from Gruithuisen's free-living *N. diaphana*. Ehrenberg distinguishes two species, his *Ch. furcatus* being probably synonymous with von Bär's *Ch. limnæi* or Gruithuisen's *N. diaphana*, whilst his *Ch. niveus* is a distinct free-living species. D'Udekem speaks of two species (probably the same two as Ehrenberg) as *Ch. diaphanus* and *Ch. Mülleri*; it is not possible, however, from his very brief notice, to tell what are the characters of his species. Grube and Baird use Müller's specific name *vermicularis*, and do not give definite characters, whilst Oscar Schmidt, in a general anatomical paper, speaks of *Ch. diaphanus*, meaning probably Gruithuisen's species, which is the same as that figured by Leydig in his 'Lehrbuch' and in his beautiful plates of the nervous system of Annulosa. From this it appears pretty evident that von Bär's name of *Chætogaster limnæi* has priority for the species I am about to describe, and that there is a free-living species (of which I shall speak further) to which Müller's name might be applied, but which, to avoid confusion, it will be better to call with Ehrenberg *Ch. niveus*; also that there is a third species, *Ch. diaphanus*, differing in some details from *Ch. limnæi*, especially in the form of the setæ and in its size. The only recent accounts of the anatomy of *Chætogaster* are a brief note by O. Schmidt on the nervous system, and Leydig's two figures, which are not by any means complete.

General Appearance and Habits.—On most specimens of *Limnæus stagnalis*, and also

on some of the larger river species, some specimens of *Chætogaster limnæi* are to be found. They appear as minute whitish creatures, rarely more than $\frac{1}{10}$ inch in length, though some chains of zooids, produced by gemmation, may have a length of as much as a sixth of an inch or even more. They crawl rapidly over the surface of the snail's body, and, when one tries to catch them, retire rapidly towards the shell, beneath the velum or tentacles. Their action in moving is like that of a Geometric caterpillar, their bundles of hooked bristles being used like the "feet" of the larval Arthropod. They do not appear to incommode the *Limnæi* by their presence, as I have found specimens of the mollusks infested by hundreds, and quite as healthy as those on which none or only one or two of the parasites could be found. Indeed they are probably useful to their bearers, since their alimentary canal is often distended with the *Cercariæ* of the *Limnæus*, as well as with small Entomostraca, Rotifera, Protozoa, and Protophyta. In the month of December I could find no specimens of *Chætogaster* on any *Limnæus*, nor in January; in February I found, on a *L. stagnalis* at Oxford, a well-grown specimen, with a zooid and portions of two growing zooids attached; it was enveloped in a thick mucous secretion of the snail, and was apparently torpid; in March I have found none; in April none; in May all the *Limnæi* appeared suddenly to become infested with them, and continued so until the end of November, when they again completely disappeared*. The same *Limnæi* were not kept and examined from time to time, as it is almost impossible to preserve large individuals of these mollusks in a limited vessel of water; they are so voracious that all vegetation is destroyed by them, and the water becomes putrescent from the abundant fæces; the delicate worms rapidly die under these circumstances, not breathing, like their bearers, atmospheric oxygen. The *Limnæi* from one pond at Oxford and one at Hampstead, however, were repeatedly examined, and gave the results stated above. Every specimen of *Chætogaster limnæi* which I have seen was in a state of gemmation, some with only one not fully grown zooid attached, others with four or eight or portions of more individuals, forming a long chain. Not a single specimen of *Chætogaster* in an undoubtedly sexual condition has come under my observation†, nor, I believe, under any one's, unless the dubious description and figures of D'Udekem are to be accepted.

General Characters.—A single individual of *Chætogaster limnæi*, taken by itself, without its attendant train of zooids, is less snake-like in outline and less distinctly segmented than most worms, having something of the short stumpy figure of a grub or Tardigrade. Its mouth is almost terminal—the dorsal margin being capable, however, of a certain amount of protrusion, like a lip or "prostomium." There is a pair of bristle-bundles on the ventral surface near the mouth, each having twelve long bristles, with reflected bifid apices; at some distance from these another series of bristle-bundles

* In the month of February I have found the *Chætogasteres* in great numbers *inside* the *Limnæi*, apparently having entered by the renal duct. They had gorged themselves with the peculiar cells of the kidney, and looked at first as though distended with ova; they were, however, still asexual, and formed very large chains of zooids. Professor Huxley drew my attention to their occurrence *within* the Water-snails.

† While this is going through the press, I am able to correct the above statement. I have now found the sexual condition, which differs in important characters from the asexual. I reserve a description of this form.

commences, in each of which there are eight hooklets shorter than the cephalic, but similar in all other respects. An individual *seems* sometimes to have seven or eight of these "abdominal bristle-bundles," as they may be called, in distinction from the "cephalic bristle-bundles;" but this is not really the case, as the study of the development of the zooids shows that the posterior four belong to a new zooid. Four abdominal bristle-bundles are all an individual possesses; how many segments are indicated by these and the cephalic bundles is questionable. The muscles and integument at the insertion of each abdominal bristle-bundle form an elevation on the surface of the body, comparable to a foot in the Polychæta, and give this species of *Chætogaster*, when they are in action, a curious resemblance to some Tardigrada. The bristle-bundles are used simply for locomotion, and each can be spread out like a fan or turned so as to point the reflected apices in any direction. The cephalic bristle-bundles are not used for prehension of food (which is effected by the rapid and powerful intermittent sucking-action of the pharynx), but perform the same part in locomotion as the anterior sucker of a leech or the anterior feet of a caterpillar. The form and number of the bristles, and the general proportions of the body, are the points which give the best specific characters in *Chætogaster*.

*Common Characters of the Tissues**.—*Chætogaster limnæi* is almost perfectly colourless and transparent, the only colour developed in its body being in a few brownish granules surrounding the alimentary canal, which often also contains coloured matter. This does not render the observation of its organs and structure at all easy, since there are no contrasting tints to guide the eye. At the same time the density of its various tissues appears to be very equal, and little more than that of the surrounding water. This condition of things, which is found in Infusoria and many low Turbellarians, is connected with the fact that when they are crushed and water admitted freely to mix with the tissues, they rapidly swell up, dissolve, and almost entirely disappear. This being the case with *Chætogaster limnæi* renders any dissection of it impossible. It may be flattened to a certain extent by pressure; but when the creature is once burst, it soon becomes a mass of floating cells and vesicles, many of which are evidently *produced* by the action of the water. In the living *Chætogaster* the histological elements to be distinguished are—homogeneous substance, granules, fibrillated substance, hexagonal, compressed, and floating globular cells.

The Integument.—By the use of weak acetic acid a superficial structure ("matrix" of Leydig), consisting of small closely fitted hexagonal cells with rounded nuclei and nucleoli, is rendered very evident in the integument of the worm (Plate XLIX. fig. 32). A very delicate "cuticle" is all that lies externally to these cells; and filamentous prolongations of the substance of the cells are very abundant on some parts of the body, particularly towards the anterior region and on the lip. They are similar to hair-like processes in *Nais*, in *Sagitta*, in young Annelida, and the Turbellaria generally, such as Dr. Strethill Wright has proposed to call "palpocils." In this tessellated layer are disposed at intervals large clear oval bodies, which are so numerous and large, in some specimens, as to produce

* These remarks apply to the immature, asexual condition. Important histological changes go on when the genitalia are developed.

a warty corrugated appearance. These clear "cells" or vesicles are found occasionally in the integument of various Oligochæta, where they appear to be much more localized than here, or rendered less obvious by the intervention of other structures. In *Æolosoma* the translucent red bodies in the integument are undoubtedly identical structures; in *Parthenope* of Schmidt, or *Ctenodrilus* of Claparède, and in *Thysanoplea* of Schmidt similar bodies appear to be very numerous; whilst the clear vesicles in the integument of very many Planarian worms belong to the same order of structures.

Beneath these bodies we come upon the muscular body-wall. The bristles of the bristle-bundles are colourless and quite structureless, but apparently horny. The stem is scarcely sigmoid, and swollen slightly at its insertion; the apex is turned at right angles to the stem and is bifid, forming a small prehensile organ (fig. 15). The average length of the cephalic bristles is $\frac{1}{220}$ inch, being nearly the same as the average diameter of the worm when not *flattened* by pressure. The abdominal bristles are about $\frac{1}{400}$ inch in length, or less. Their number and characteristic distribution has been already spoken of. In growth they appear at first as straight hookless stumpy bristles, and are even then, when near the posterior extremity, used for prehension. Leydig has stated that each bundle is in reality double, as may be seen by the use of an acid. I am quite sure that this is not true with regard to *Ch. limnæi*.

Muscles.—The muscular layer of the body-wall is not, in these asexual forms, perceptibly divided into transverse and longitudinal layers, though it contains fibres of both directions, as may be seen by the use of acetic acid. There is considerable differentiation of the muscular layer in connexion with each bundle of bristles, the fibres being so arranged that the bundle of bristles may be spread out like a fan with the hooklets pointed in any direction. The muscles of each pair of abdominal bristle-bundles do not act separately, but the whole series seems to be moved by the same set of muscles, whilst the cephalic pair of bundles are distinct. Many fibres exhibit a cellular character (fig. 28).

The pharynx is worked in its sucking-movements by very numerous fibres passing from it to the neighbouring body-wall, which is cellular.

No special structure can be assigned to the muscular fibre; it appears merely as a substance broken up into elements, each one of which is too small or indefinite to present any character.

Alimentary Canal.—The mouth cannot be said to be exactly terminal, as in the figure given by Leydig of *Ch. diaphanus*. It is capable of assuming a terminal position when stretched and widely open; but when closed a portion of its dorsal margin projects beyond it to a small extent, representing the "prostomium" or "Kopflappen." This lip is muscular and very moveable, and is supplied with many nerves from the prostomial or supra-œsophageal ganglion (figs. 13 & 25). The mouth opens into a very extensive and highly elastic pharynx, which, as before said, is closely connected to the body-wall by muscular fibres, and by its rapid alternate expansion and contraction draws in the Infusoria, Cercariæ, &c. on which the worm feeds. At the junction of pharynx and œsophagus is a bulbous enlargement, which lies above a sort of nerve-ganglion. The food having been drawn into the pharynx, the mouth is tightly closed, and by a contraction the mass is forced through the short, narrow, and elastic œsophagus into the stomach (figs. 19–22). The

surface of the pharynx often presents the appearance of a complicated network of vessels formed by the breaking up of the principal vascular stems (figs. 17, 18); but this is perhaps due only to plication.

The *stomach* is a large, somewhat square sac, often very largely distended with food and pressing against the body-wall; a few (apparently irregular) muscular septa pass from the body-wall to it. It is very largely moveable in a longitudinal direction, but usually its posterior portion underlies the first pair of abdominal bristle-bundles. The outer surface of the stomach and the intestine (which is quite similar to it, being merely separated by a constriction) is traversed by a series of capillary vessels, which are difficult to detect and by no means so clear or definitely arranged in *Ch. limnæi* as in the species figured by Leydig in his 'Lehrbuch.' They branch from the main dorsal vessel, and, like it, are surrounded and marked out by closely packed brownish granules, which vary in number in different individuals. Beneath these vessels and granules is a layer of large hexagonal flattened cells, which are ciliated and contain yellow granules. The inner surface of the stomach and intestine is ciliated, the cilia being extremely fine and quite invisible, except under the most favourable circumstances; for a long time they entirely escaped me (fig. 37). There is no differentiation of intestine or anus, since the growth of zooids is continually proceeding behind, and what was the intestine of one individual becomes the stomach of another, but never the pharynx or œsophagus—these parts always being developed distinctly, from a deposit of homogeneous matter.

Nerves.—The nervous system is a little difficult to make out satisfactorily; and in *Ch. limnæi* I have not observed what Leydig has put forward, with reference to the main trunks, in his drawings. It is easy to see, when a ventral view is taken of the worm under slight pressure, the infraœsophageal ganglion, its commissures passing round the pharynx, and the longitudinal "cord" passing posteriorly and surrounded by lobulated tissue on the surface of the pharynx, as in fig. 12. It is easy to trace this further over the pharyngeal bulb, where there is much of the lobular tissue; and the cord may be vaguely followed beyond this to another similar swelling below the stomach, where it becomes lost by its own transparency and indefiniteness. The relations of the supraœsophageal ganglion, however, are more difficult to ascertain. When a dorsal view of the worm is obtained, it may, with great care in focusing and illumination, be distinctly defined (figs. 14, 24). It is a broad band of nerve-tissue, swelling towards the centre, and branching out into fine twigs in both an anterior and posterior direction. Leydig has figured a second suprapharyngeal ganglion, connected also by commissures with the infrapharyngeal mass, and apparently corresponding to a stomatogastric centre, or the specialization of the pharyngeal plexus, existing in *Lumbricus*; I feel persuaded that such a structure does not exist in *Ch. limnæi**, and am rather puzzled to account for the difference. It is either a specific distinction, or is due to the immaturity of *Ch. limnæi*, or the observations are incorrect.

Some four or five twigs pass off from the suprapharyngeal ganglion to the lip or

* In the sexually mature specimens of *Ch. limnæi* all the structures here described are more readily seen. The nerve-system is certainly as stated above; but from an examination of *Ch. diaphanus*, I am now able fully to confirm Leydig's figure of that species.

prostomium, whilst a larger number pass posteriorly, forming a sort of network on the pharynx, with the substance of which they appear to fuse. Leydig has figured the anterior nerve-twigs as terminating in oval nucleated cells; but this I have not found to be the case. The enlargement which underlies the œsophagus proper is a flattened lobular mass, giving off two principal horizontal trunks, one on either side (fig. 25); posteriorly to this the nervous system becomes very obscure. The lobulated tissue on the pharynx, which forms the ganglia and surrounds the cord at different points, appears to represent cellular nervous tissue; it branches out in various directions, and breaks up into little twigs. Occasionally small clear cells with nuclei may be seen scattered in its substance; but the character of the nervous tissue in these immature forms is that of a homogeneous protoplasm.

In the production of zooids it appears that the element of the ventral cord remains continuous throughout the chain until a separation is very shortly about to occur.

The Vessels and their Fluid.—The extensive system of vessels to be detected in *Chætogaster limnæi*, identical with the closed system of vessels in all Annelids but the Leeches, which are not rightly called Annelids, contains a colourless fluid. The red fluid of other Annelids contains red cruorine, and is undoubtedly efficient in respiration; so, too, this colourless fluid contains a respiratory medium (an oxygen-carrier) like green or red cruorine, though colourless, and is, as are the colourless vascular fluids of other Annelids, efficient in respiration. The minuter ramifications of the vessels may be detected by a curious optical property presented by fluids in exceedingly narrow tubes, namely, their pinkish or purple tint*. The fluid in larger vessels appears (as it is) quite colourless.

The vessels which distribute this fluid over the body are difficult to trace out fully; but in this species I do not find the arrangement to be the same as that described by Leydig in his 'Lehrbuch,' where he gives a diagrammatic figure of some of the vessels of *Chætogaster*. We have, in the first place, what may be a peripheral capillary network traversing the whole surface of the integument, and performing the respiratory function of the worm. We have a second or intestinal capillary network, apparently not provided with such minute branches (figs. 12, 13, 14). I have only been able to make out two great longitudinal trunks—a dorsal and a ventral. The dorsal is a powerful and highly contractile vessel, giving off the large branches to the intestinal system, and probably also to the tegumentary, peripheral, or respiratory system; but this I have not seen. At the region of the œsophagus it gives off on either side a highly dilatable coiling vessel, which joins the ventral trunk; each of these represents one of the moniliform "hearts" of the earth-worm. The dorsal vessel itself passes on, giving off numerous branches on the surface of the pharynx, and, passing beneath the suprapharyngeal nerve-collar, breaks up into two large lateral trunks, and also into small stems which form a vascular ring round the mouth (figs. 12, 14 *lpv*). The two lateral vessels pass down the neural sur-

* I have observed this repeatedly in *Chætogaster*, where it has assisted me very much in tracing vessels, also in the pulsating cavities of Infusoria, and in the minuter ramifications of the canaliculi of the lacunæ of cement from teeth. Dr. Zenker, in a recent number of Max Schultze's Archiv (Bd. ii., p. 332), alludes to this phenomenon in Infusoria, and ascribes it to the law of complementary colours, the *substance* of the Infusorian having a bluish tint.

face of the pharynx and join to form a single ventral vessel close to the bulb of the pharynx. Here, too, almost at once, are given off the two highly dilatable lateral vessels. The ventral vessel is non-contractile and is not adherent to the wall of the intestine (see figs. 12–14).

The dorsal vessel does lie closely on the intestine-wall, and becomes covered in parts, as do its main branches, with aggregations of minute brownish granules. The vessels of the tegumentary or respiratory system of course meet the great trunks and the intestinal system at either end of the worm, and are, it is to be supposed, elsewhere connected by branches from the dorsal and ventral trunks. Parallel vessels passing transversely almost round the worm are arranged at close intervals, and connected by the finest interweaving capillaries (fig. 23). This constitutes the respiratory system. The interweaving capillaries are perhaps rather lacunar spaces in the tissue than capillaries with walls, but seem eminently adapted, from their position and structure, to facilitate a free interchange of the gases of the vascular fluid and surrounding water. I must, however, express a doubt (which I cannot clear up) as to whether these apparent vessels may not be simply furrows or thickenings of the integument.

Perivisceral Cavity and Fluid.—The space between the alimentary tube and the body-wall in *Chætogaster limnæi* is larger proportionally than in the Lumbricoids, but not so great as in *Æolosoma*. It is traversed by numerous muscular bundles at the pharynx; and a few pass to the stomach—one apparently septal muscle extending across it at the anterior end of the stomach, and another at the posterior constriction dividing stomach from intestine, and perhaps another for each succeeding pair of bristle-bundles. It contains, of course, a fluid, in which float granules and cells, and in which are suspended the *segment-organs*. The granules and cells vary to a very great degree in number; in some individuals there are hardly any, in others the cavity seems packed with them. There is a very distinct relation between the abundance of the perivisceral granules and cells and the abundance of the brownish granules which surround in masses the dorsal vessel and its ramifications on the stomach or intestine. Claparède, in his 'Recherches sur les Oligochètes,' has spoken of the brown-yellow 'hepatic' tissue of the intestine in *Lumbricus* being continued to and surrounding the dorsal vessel, and has hinted (but only obscurely) at some connexion between the perivisceral cells and the supposed hepatic tissue. D'Udekem, also, in his memoir on *Tubifex*, has connected the two. It seems not at all improbable that this yellow glandular tissue may have but little to do with the secretion of digestive juices, or, at any rate, may have an additional and most important connexion with the production of the corpuscles of the perivisceral fluid, and may serve to place that fluid in organic relation with the liquid of the closed vascular system of the intestine and the contents of the digestive tract. When I have found the perivisceral fluid devoid of granules, I have observed clustered masses of granules adhering to the dorsal vessel and to its larger branches, or sometimes one or two such masses floating alone in the perivisceral cavity (fig. 26, *a e*). On the other hand, when the cavity has been full of corpuscles and granules, the vessels of the intestine have been almost entirely free from granular matters. The corpuscles found in the perivisceral fluid differ not only in number, but in kind, in different individuals. There

may be one or two clustered masses of granules; these may be broken up into smaller clusters enclosed by a sort of cell-wall; or the granules may be free and separate; or they may have assumed the form of hyaline corpuscles with nucleus and nucleolus (fig. 26 *a*, *c*, *b*, *d*).

Segment-Organs.—These organs have not hitherto been mentioned by those who have incidentally alluded to other points in the anatomy of *Chætogaster*. They vary very much in their development in different individuals. In some they are only to be detected, by most careful adjustment, as minute tortuous tubes lying beneath the integument. In others they have attained a considerable size, and hang as folded masses in the perivisceral cavity. In no case are they large enough to admit of their true structure or parts being clearly recognized. Figure 29 represents all I have been able to see in the asexual *Chætogaster**. I could not detect the free end, corresponding to the funnel or "entonnoir vibratile" in other worms; but at one end there appeared to be a dilatation representing the atrium. A pair exists in front of the first pair of abdominal bristle-bundles, and another pair between each succeeding pair of bristle-bundles. Whether they open externally or are ciliated I cannot say; but it cannot be doubted that they represent the segment-organs of other Annelids.

The Number of Segments forming an Individual.—I have already mentioned that this is a difficult matter to decide, inasmuch as zooids are continually being produced posteriorly, and that not in a linear progression, but by a continuous growth posterior to the third pair of abdominal bristle-bundles. Do the cephalic pair of bristle-bundles and the three abdominal pairs each indicate a segment or, rather, a head-segment and three ordinary segments? I think there is reason to answer this in the affirmative, since a sort of septal muscle or diaphragm divides off the pharyngeal portion from that in which the intestine commences as a stomach. This, again, is marked off by an obscure diaphragm from the succeeding region, which is also thus obscurely divided into segments corresponding to the bristle-bundles. In each of the divisions thus made, there is, excepting in the pharyngeal, a pair of segment-organs; but there is no constriction of the anterior part of the worm in correspondence with these supposed segments.

Segmentation in Vermes may be regarded as (and probably is) the result of the arrest of the production of zooids by terminal budding. If this be the case, the unparalleled paucity of segments exhibited by *Chætogaster* is directly connected with its enormous fertility in the production of zooids. The "tendency to integration" (*Herbert Spencer*)†

* Of this and other structures I have made out more in the sexual forms.

† I have found, since the above was written and read, that Mr. Herbert Spencer has himself applied his laws of Evolution to the explanation of what has been vaguely termed "vegetative repetition." In his excellent chapter "On the Morphological Composition of Animals," in the second volume of the 'Principles of Biology,' he regards Annulose animals as tertiary aggregates, each somite being considered a secondary aggregate; and he has brought together a most convincing and interesting series of facts to support his argument. There is one matter on which he does not touch, which I think is elucidated by the study of the growth of zooids in such Annulosa as *Chætogaster*; and that is the morphology of the head. Is the head, in those Annulosa in which it presents a quasi-segmented condition, to be regarded as composed of modified zooids? or is its segmentation (in the higher Annelids and in Arthropoda) to be considered *superinduced*? In many mollusca and in the vertebrata we find a head presenting a segmented condition or a certain repetition of parts. In these the structure is regarded as superinduced in a secondary

is smaller in *Chætogaster* than in the higher Oligochetes, and hence fewer zooids are held together to constitute an individual. Were it still less, we might have an Annelid of but one segment, resembling in this a Rhabdocele Turbellarian, a *Sagitta*, or other simple worm, having a head, digestive tract, prostomial and ventral nerve-ganglia, and a pair of excretory segment-organs, with cephalic and abdominal bristles. The growth of the head *always* in an anterior direction, as an addition to the otherwise completed zooids of *Chætogaster*, seems to show that the head is something distinct from the other segments, and not comparable to them, whilst it also tends to explain each ordinary segment as an incomplete zooid, and is further connected as cause and effect with the subsequent separation of the zooid at the plane in which the tendency to anterior development was first sufficient to overcome the longitudinal cohesion. The anomalous cephalic bristle-bundles of *Chætogaster* may be compared to, and are perhaps homologous with, the temporary cephalic bristles of larval Polychæta, or with the jaw-like setæ of *Sagitta*; or, on the other hand, they may be related to the setæ discovered by Professor Huxley in connexion with the peristomial cirri of Polynoïna.

The Fissiparous Reproduction of Chætogaster limnæi.—A few words are necessary as to the order of the production of zooids, and the relations of the "segments" which

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aggregate, and not as the result of tertiary aggregation. The same reasoning will, possibly, when applied to the head of Arthropods and Annelida, lead to the conclusion that its segmented structure is also superinduced, and that peristomal and prostomal regions (forming "the head") are essential parts of the unisegmental secondary aggregate. If this be the case, a head can only be homologous with a head; and the difficulties of reconciling variations in the typical number of "somites" are much lessened. In the development of the zooids of *Chætogaster*, the cephalic bristles, pharynx, and surrounding parts are produced by growth in an *anterior* direction, the rest of the first segment is completed by *posterior* growth, the two axes being separated by an indifferent plane. The first segment forms a simple secondary aggregate. This is exactly comparable to the early development of the ovum of marine Annelida and of Arthopoda: in the former the rudiments of the prostomal and peristomal region, with the temporary bristles and little else, form the simple secondary aggregate, which subsequently gives rise to the worm; in many of the latter the early development of the prostomium and its appendages has been observed to take place much sooner (without the production of segments by budding) than and in a different axis from that of the zooid somites, which are afterwards produced and integrated to form the complete myriapod, crustacean, or insect (see the researches of Newport, Mecznikow, and Dohrn). The bud-somites in *Chætogaster*, then, are produced posteriorly; but they are incomplete, they do not develope a head; there is a *longitudinal cohesion* or *integration* which counteracts this. Where first the longitudinal cohesion becomes weak, the tendency to anterior development prevails, and the normal head grows, and a new individual separates. In most Annulosa this longitudinal cohesion counteracts entirely the opposing tendency to produce a head and to separate. It is conceivable that as the leg of the Arthropod, the cirrus of the Annelid, or the pygidium is jointed in conformity to the incident forces to which it is exposed, so the prostomial region of Annulosa may acquire a segmented or jointed structure: but in very few cases is such a structure traceable, the repetition of general form in its appendages (in accordance with a repetition of external forces) being the principal fact tending to indicate it, whilst the axis itself is very generally simple. The cephalic appendages of a *Helix*, or the rows of branchiæ in an *Eolis*, might be taken as indicating true gemmiparous segmentation, if the appendages alone of the head in Annulosa did so.

But if the identity of the anterior cephalic somites in Annulosa with arrested gemmæ be considered established by the common plan of their structure, we must compare the cases of anterior and lateral gemmation in Annelids recorded by Le Vaillant and others, *and must distinguish the head-gemmæ as belonging to a separate axis of growth and gemmation*, and not exchangeable with those of the body. At all events it is necessary to regard the simple unisegmental Arthropod and Annelid as possessing a *head of its own*, as essential and proper to its individuality (as a secondary aggregate) as the head, or pro- and peristomal region of a Turbellarian, a Mollusk, and a Vertebrate.

are one after the other concerned in their production, and may throw some additional light on the subject mentioned in the last paragraph. Professor Claus, in the 'Würzburger Zeitschrift,' has a short paper on the order of the growth of zooids in a chain. He noted that as to age or condition of development they do not follow as they are attached, one behind the other, the first, second, third, and fourth being relatively first, second, third, and fourth in age, but that, whilst the first is of course the oldest or parent zooid, the second in position is one of the newest, the second in age being near the middle of the chain. He has observed chains of as many as sixteen zooids, and gives the following formula as expressing the simple law of their relative age or period of development. If n be the number of zooids in a chain, the formula gives the sequence of zooids in *age*, each number representing the zooid whose *position* is indicated by that number

$$1, \frac{n}{2}+1, \frac{n}{4}+1, \frac{3n}{4}+1, \frac{n}{8}+1, \frac{5n}{8}+1, \frac{3n}{8}+1, \frac{7n}{8}+1$$

$$\ldots\ldots n-1, 2, \ldots \frac{n}{8}, \frac{5n}{8}, \frac{3n}{8}, \frac{7n}{8}, \frac{n}{4}, \frac{3n}{4}, \frac{n}{2}, n.$$

This obviously results from the fact that each zooid is continually growing and producing fresh zooids, and that, even before a zooid has become marked off from its parent in front, the parent has begun to produce a new zooid. That this is the case can be satisfactorily determined by examining chains of zooids, whose relative ages are at once determined by their comparative development. The simplest *Chætogaster* I have seen is one consisting of a head and six segments (indicated by the abdominal bristle-bundles), between the third and fourth of which a fresh segment was beginning to make its appearance. From the examination of various specimens, for *one* cannot be kept and traced, the process appears to continue thus:—An eighth segment also begins to grow simultaneously with the seventh, growing between the third and fourth of the original worm; and then a homogeneous blastema is deposited about and between the new fourth and old fourth segments; in this, by anterior growth, the head of a zooid whose body is formed by the old fourth, fifth, and sixth segments is developed, and, simultaneously, a new segment is added to the new fourth segment, and the terminal segment of the chain. Before this has proceeded long, new segments arise in another plane of growth, namely, one between the third and fourth of the first zooid, and one between the third and fourth of the new zooid; and thus the whole process repeats itself in each case, both in parent and zooid. The three segments succeeding a head are never separated, they remain permanently attached when once grown; but the fourth segment, with the two that develope behind it, is continually being detached by the growth of a head between it and its parent. The whole phenomenon is then reduced to this simple statement:—An individual *Chætogaster* consisting of a head and three segments is continually producing additional segments, by posterior growth, from its third segment; the fourth segment, counting from the head, has simultaneously a tendency to growth in an anterior direction, forming a head; or, in other words, the integration or longitudinal cohesion of the chain of segment-zooids is consistently overpowered at the fourth, by the tendency of that segment-zooid to anterior growth, or to its completion by the

development of a head. If this be a correct statement of the production of zooids in *Chætogaster*, it would come under the last of the three groups into which Professor Huxley some time since divided the phenomena of fissiparity in Vermes, namely, that in which "none of the segments of the produced zooid belonged to the parent stock—and the former contains hardly any of the primitive substance of the latter, being developed by gemmation from its last segment."

II. *Remarks on* Chætogaster niveus, *Ehrenberg.*

In some water containing confervæ, from the river at Oxford, examined in May, I found a *Chætogaster* differing very greatly from that parasitic on the *Limnæus*, and identical, I believe, with that figured by Ehrenberg in his 'Symbolæ Physicæ' as *Ch. niveus*. This worm was hardly more than $\frac{1}{8}$ inch long, thin and active, and apparently with a firm, tense integument, very different, so far, from *Ch. limnæi*. The whole worm was much narrower and more elongated than that species, and by no means so transparent. The prostomium (figs. 9 and 10) was longer and more obvious, the pharynx was longer and apparently thicker in the walls, and the œsophagus was very much longer. The vascular network on the intestine was more obvious in this species, though the other vessels, segment-organs, and nervous system it seemed almost impossible to define.

The most characteristic difference, however, was found in the bristles, which were proportionally much longer and thinner, and quite different in shape; instead of having a reflected apex, it was simply bifid, the point being very fine, and the bifid structure very hard to see distinctly with a quarter-inch objective (fig. 11). In number the bristles agreed with those of *Ch. limnæi*. The mode of using the cephalic bristles was much more rapid than in the parasitic species. The cephalic bundles were suddenly thrown out laterally on either side of the head, and retracted, and thus worked up and down, enabling the worm to move very rapidly. One specimen which I observed presented only five abdominal bristle-bundles, of which the two posterior were demarcated as though belonging to a developing zooid.

Ch. niveus is evidently fitted for a more active life than *Ch. limnæi*; but it differs from *Ch. diaphanus*, which is non-parasitic, in the same particulars. The *Ch. diastrophus* of Gruithuisen may possibly be this species.

III. Æolosoma quaternarium, *Ehrenberg, and its embryonic form.*

Ehrenberg first observed *Æolosoma* in Dongola,—a wonderfully elastic, transparent, spotted little worm, living in running waters; he was afterwards astonished to find it near Berlin. I believe no figure or description of the worm has been published since Ehrenberg's 'Symbolæ Physicæ,' 1828, excepting D'Udekem's account as to the generative glands*. The specimens I have examined were obtained by Mr. Charles Robert-

* Since the above was written, I have found a paper by Leydig in 'Reichert's u. du Bois Reymond's Archiv fur Anatomie,' 1865, in which he shortly describes two species of *Æolosoma*, one of which he identifies with the *Æ. quaternarium* of Ehrenberg, and the other he calls *Æ. niveum*. Professor Leydig obtained his specimens from the Main, and appears to have had them under observation no longer than myself. In almost every particular our descriptions agree, excepting as to the production of zooids and as to the young form. Professor Leydig speaks of the coloured

son, demonstrator of Anatomy at the University Museum, Oxford, in a bottle of water from the river, in which they made their appearance during May. The largest specimens I observed were nearly $\frac{1}{4}$ inch in length; nearly all were producing zooids by posterior gemmation.

The outline of the worm is very loose and uncertain, the body flowing in various directions in a very strange liquid fashion, the alimentary tube within also exhibiting the most free and independent movements, as though not bound in any way to the integument or body-wall. The prostomium is most remarkably developed, broad and flat, reaching far in front of the mouth, and abundantly ciliated. The setæ, or bristles, are very fine and hair-like; the bundles are in a double series on each side of the body, two dorso-lateral bundles and two ventral bundles to each segment. The body is not distinctly segmented, but shows more approach to annulation than in *Chætogaster*; apparently a head and six segments constitute the individual. There are no cephalic bristle-bundles like those of *Chætogaster*; and so, in estimating the individual, we reckon a head, and a segment for each set of bristle-bundles. The zooids are produced by the constant tendency of the sixth segment to bud, or the failure at this point of the longitudinal force which counteracts the force of growth in an anterior direction and formation of a head. The prostomium of a zooid when formed, projects in a very strange way from the zooid, as seen in the figure (fig. 5). I have only seen chains of two zooids with portions of two others incomplete behind them.

The integument is ciliated on the ventral surface of the prostomium, and nowhere else. Its most remarkable feature is found in the oval vesicles which are scattered all about it like the clear vesicles in *Chætogaster limnæi*, but which are of a clear blood-red colour, whence the name *Æolosoma*. I have not succeeded in bringing this colour under the micro-spectroscope.

The fluid in the *system of vessels* is of a pinkish colour. There is the usual large contractile dorsal stem; and the ventral stem appears to break up on the intestine.

The *perivisceral fluid* presents very few granules or corpuscles. The *mouth* opens into an alimentary tract which is most densely covered with coarse, active cilia throughout its length; the food appears to be brought in, to a very great extent, by the action of these cilia and those on the broad expanded lip or prostomium. The *pharynx* is short and muscular; the *œsophagus* is a long tube folded or twisted on itself, and opens into the stomach or intestine, which commences with the third segment, and runs through the body, hanging very loosely by a few muscular septa, becoming constricted and narrow at the end of the sixth segment. There is in each segment except the head a large well-developed *segment-organ*, which appears as a tortuous, coiled canal, densely within. The ***nervous system*** is very obscure.

In the water, with the *Æolosoma*, I observed some small creatures which I take to be the young form hatched from the egg. In fig. 4 one of these is drawn. There is the

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tegumentary vesicles or spots as fat-drops. He has been unsuccessful in detecting the sexual condition of *Æolosoma*, and observes that D'Udekem's figures of the genitalia are so unlike *Æolosoma* in other respects that they must be considered "sehr schematisch." Dr. Maggi has also lately published a memoir at Milan, which I have failed to see.

large ciliated prostomium and the mouth projecting outwards; the alimentary tract is ciliated throughout, but the outside of the body is not, excepting the prostomium. A few stiff hairs or "palpocils" project from the integument, such as are well known in young *Turbellaria*, in *Nematodes*, and in *Nais* and *Chætogaster*, and which are seen also in the adult *Æolosoma*.

The specimens of *Æolosoma* disappeared from the water that contained them, and I could get no more. As it is unlikely that I shall succeed in so doing yet a while, I do not think it necessary to keep back the above notes, though incomplete.

Ehrenberg describes three species of *Æolosoma*. I suppose that my species is his *Æ. quaternarium*.

IV. *Relations of* Chætogaster *and* Æolosoma *to some other low forms of Annelida.*

Æolosoma and *Chætogaster* are both associated by D'Udekem and J. V. Carus with *Nais*, in the lowest of four families into which the Oligochæta are by them divided; at the same time no mention is made of two other low forms with which they ought to be associated. *Æolosoma*, in its double series of bristle-bundles, in its large prostomium, in the coarse ciliation of its alimentary tract and lip, and in its larger number of segments and greater differentiation of its tissues, certainly presents characters which bring it nearer to *Nais* and the Lumbricoid Oligochetes than any presented by *Chætogaster*. But it also approaches *Chætogaster* in the paucity of its segments, the red vesicles of its integument, and the comparative lowness of its organization. *Æolosoma* is, it appears to me, much nearer to *Nais* than to *Chætogaster*. Are there any forms which bridge over the gap?

Oscar Schmidt, in the 'Sitzungsber. Akad. Wien, vol. xxiii., describes very briefly a *Parthenope serrata*, which seems to have been quite overlooked since. Claparède, in his 'Beobacht. über Anat. u. Entwickelung der wirbellosen Thiere,' describes briefly and figures the same worm under the name *Ctenodrilus pardalis*. He does not allude to Schmidt's species; but undoubtedly his is of the same genus. Claparède's figure is the most complete; he remarks that he considers the worm to be a marine Oligochete, but has only met with it once, and he gives no anatomical details. Neither Schmidt nor Claparède says anything as to the relations of this worm to the Oligochæta. It is a minute creature, of the same size as the *Ch. limnæi*, or even less, has a short worm-like figure, but no definite segmentation, whilst its integument appears not to be tough. Its setæ are pectinated at the apex, or, rather, notched with five teeth; they are arranged in bundles of five placed in pairs on the ventral surface; Claparède figures five such pairs. The prostomium is very large, and ciliated like that of *Æolosoma*, whilst the integument is spotted with brownish clear vesicles arranged in clusters, whence the name *pardalis*. This form very obviously connects *Chætogaster* and *Æolosoma*, having the ciliated prostomium of the one, and the uncinate bristles, in a ventral series, of the other. Both Schmidt and Claparède found it in the Mediterranean. The ciliated broad prostomium of *Æolosoma* is strangely like that of some Turbellaria, as for instance *Microstomum lineare*, in which the mouth and prostomium have almost exactly the same

relations as in *Eolosoma*. A curious form, described by O. Schmidt in his paper already alluded to, seems also to belong to the group formed by *Chætogaster*, *Parthenope*, and *Eolosoma*; he figures it and briefly describes it as *Thysanoplea luctuosa*. In this worm the integument contains the same vesicular bodies characteristic of the above genera, and to such an extent as to give it a warty appearance; there are a few bundles of delicate hair-like setæ, and a short prostomium; but the description of Schmidt does not enter into anatomical details, and the worm appears to be very minute and difficult to study.

The anomalous chætognathous *Sagitta* may fairly be compared to *Chætogaster*, if it is regarded as a *unisegmental* form. In comparing *Chætogaster* with other low forms of Annelida, the great difficulty is presented by its specialized cephalic bristles. The only other case in which such bristles are present is *Sagitta*, and the larval forms of Polychete Annelids. If we deprive *Chætogaster* of its posterior segments, reducing it to a unisegmental condition, a head and body, or a product of simple anterior and posterior growth, its general morphology is not so very dissimilar to that of *Sagitta*, its integument, its cephalic bristles, and nervous system agreeing, whilst the single abdominal pair of bristle-bundles may represent the "fins" of *Sagitta*. Such a comparison is further assisted by Elias Mecznikow's description of *Chætosoma* of Claparède, and a new form, *Rhabdosoma*, in which he points out their resemblances to *Sagitta*. *Sagitta* cannot for a moment be placed in close connexion with *Chætogaster* in any natural classification; for *Sagitta* is elaborately modified on a *unisegmental* plan*, whilst *Chætogaster* is modified on a *multisegmental* plan; but that they may have had some common ancestor does not appear improbable. If annulation or segmentation is to be taken as a necessary character of the class to which *Sagitta* is now referred, it cannot remain there, since it is not segmented; such a difference, however, has not prevented the association of *Dinophilus*, *Alaurina*, and *Microstomum* with the other Turbellaria which are unsegmented, nor of Trematoda with Cestoda. The retention of imperfectly developed zooids in a chain cannot be regarded as a very important differentiating character. The moveable bristles of *Sagitta* and the character of its integument are what constitute its claim to association with Chætopodous Annelids; and it is precisely in these particulars, as pointed out to me by Professor Huxley, that it resembles *Chætogaster*. Starting, then, from such a Turbellarian form as *Dinophilus* (in which segmentation is beginning to show itself) we have on one side, very remotely placed perhaps, *Sagitta*; nearer to each we have *Chætogaster*, connected by *Parthenope* (*Ctenodrilus*) to *Æolosoma*, which leads on to *Nais* and the Lumbricoids, and is also connected to the Turbellarians by so simple a form as *Thysanoplea*.

As to the classification of the genera *Chætogaster*, *Parthenope*, *Thysanoplea*, and *Eolosoma*, the difficulties which they present are those always found with the solitary "*lower*" members of a Group. They are now put with the Naids, from which certainly *Chætogaster* differs as much as *Nais* does from *Lumbricus*; but at present it is perhaps best that they should be left together, as forming the lowest representatives of the Chætopodous Annelids. It is among them that we must look for the representatives of the lost progenitors of the Chætopoda.

* That is to say, it is a secondary aggregate.

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EXPLANATION OF THE PLATES.

Plate XLVIII.

Fig. 1. *Chætogaster limnæi*, v. Bär. A chain of zooids, consisting of two nearly complete individuals, each of which has produced segments posteriorly. The worm is *not* compressed by the covering-glass; and the foot-like appearance of the bristle-bundles, and their implantation, are well seen. Natural size $=\frac{1}{6}$ inch.

Fig. 2. A ventral view of the third pair of abdominal bristle-bundles. The worm is stretched, uncompressed, and the hooklets are directed outwards and downwards. They may be directed inwards and upwards, and some in one, some in the other direction.

Fig. 3. An outline of a ventral view of a specimen similar to that drawn in fig. 1. The head is very much extended, as is frequently done in search of food. 3 *a*. A lateral view of a specimen in the act of crawling.

Fig. 4. Probably the early stage of *Æolosoma quaternarium*, Ehrenberg.

Fig. 5. *Æolosoma quaternarium*, Ehrenberg.

Fig. 6. Lateral view of the head of the same.

Fig. 7. Supposed section to show the position of the bristle-bundles.

Fig. 8. Two setæ from the ventral (neuropodal) series.

Fig. 9. Head of *Chætogaster niveus*, Ehrenberg, showing the cephalic bristles outspread.

Fig. 10. *Chætogaster niveus*, Ehrenberg. A furrow is seen below the third pair of abdominal bristle-bundles, apparently indicating the future independence of the two succeeding segments.

Fig. 11. Setæ of *Chætogaster niveus*, Ehr. Compare figs. 15 & 16.

Fig. 12. A ventral view of *Ch. limnæi*. A little compressed and viewed with transmitted light. The figure is diagrammatic. The letters have the following signification:—*pr*, prostomium; *pr. g*, prostomial ganglion (seen indistinctly); *m*, mouth; *pc*, palpocils (on warty tubercles of the integument); *c. b*, cephalic bristles (12 in a bundle); *n*, nerve-band; *l. p. v*, lateral pharyngeal vessel; *ph*, pharynx; *l. c. v*, lateral commissural vessel (from the dorsal to the ventral vessel); *p. g*, perivisceral granules; *st*, stomach; *v. v*, ventral vessel (lying between the alimentary canal and the nerve-band); 1 *seg*, 1st segment-organ; 1 *ab*, 1st abdominal bristle-bundle (8 bristles in bundle); *i*, intestine; 2 *seg*, 3 *seg*, second and third segment-organs; 2 *ab*, 3 *ab*, 4 *ab*, 2nd, 3rd, and 4th abdominal bristle-bundles (8 bristles in a bundle); *l. d*, lines of demarcation between zooids, caused by deep grooving of the surface; *c. b. d*, cephalic bristles commencing development.

Fig. 13. Lateral view of the anterior portion of *Ch. limnæi*. *n. pr*, nerves passing to the prostomal region; *d. v*, contractile dorsal vessel; *b. ph*, pharyngeal bulb, between pharynx and œsophagus; *gr*, granules adhering to the dorsal vessel, and also free; other letters as in fig. 12. The commissural vessel of one side only is drawn.

Plate XLIX.

Fig. 14. Dorsal view of the anterior portion of *Ch. limnæi*; *æs*, œsophagus; other letters as before.

Fig. 15. Bristle from an abdominal bundle of *Chætogaster limnæi*. The space between the two hooks of the head in the engraving is too great, and the head is too large in proportion to the shaft. The direction of the hooks, however, is correct.

Fig. 16. Bristle from an abdominal bundle of *Chætogaster diaphanus*, Gruithuisen. This is a large species, attaining nearly an inch in length. Compare fig. 11.

Fig. 17. Sketch to show the longitudinal markings on the pharynx, looking like vessels, but probably due to plications caused by contraction.

Fig. 18. Do. of horizontal vessel-like appearances on the dorsal surface. The questionable vessels branching from around the mouth are also drawn.

Figs. 19, 20, 21, 22. Different positions of the mouth and walls of the pharynx in ingulfing food.

Figs. 23, 24. Appearances like vessels in the skin, probably produced by the plication of the integument.

Fig. 25. Nervous centres of homogeneous structureless substance. No distinct nerves traceable to terminations; *s s*, spaces or groovings in the middle line, irregular in distribution, and not always present.

Fig. 26. *a*, aggregation of granules such as adhere to the dorsal vessel; *b*, free granules; *c* and *e*, granules in cell-forms; *d*, nucleated corpuscles; *f*, pyriform corpuscles; *g*, kidney-cell of *Limnæus*, swallowed by *Ch. limnæi*.

Fig. 27. Appearance of the muscular attachments arising from the surface of the pharynx.

Fig. 28. Cellular fibres passing from the pharynx to the muscular body-wall, brought out by weak acetic acid. (This drawing is from a specimen of *Ch. diaphanus*.)

Fig. 29. Segment-organ from such an individual as fig. 1. The organ is very imperfectly developed, and only one of its terminations (that by which it communicates with the exterior) can be traced. There are no cilia.

Figs. 30, 31. To illustrate the growth of zooids. *l. d*, the deep grooving between the new zooid's cephalic portion produced by anterior growth and the new segments produced by posterior growth from the parent.

Fig. 32. Hexagonal cells of the "matrix" of the integument, with large clear cells intermixed.

Fig. 33. Cellular termination of fibres (muscular or possibly (?) nervous) passing from the alimentary canal to the muscular body-wall.

Fig. 34. Angular granules seen in groups beneath the integument in the most actively growing parts of *Chætogaster limnæi*.

Fig. 35. Large hexagonal cells of the stomach and intestine, containing brown granules.

Fig. 36. Two of the same, free, one showing cilia.

Fig. 37. Part of the stomach-wall in optical transverse section; *v v*, blood-vessels; *c c*, cilia lining the inner surface.

2

3

3a

10

6

7

prq.
mi

cb

lpv.
pc

12

pn

pg

vv

1seg
1ab

pd

1

2seg

2ab

3seg

3ab

1d

1ab

4a

4bd

11

8

9

n

lpv

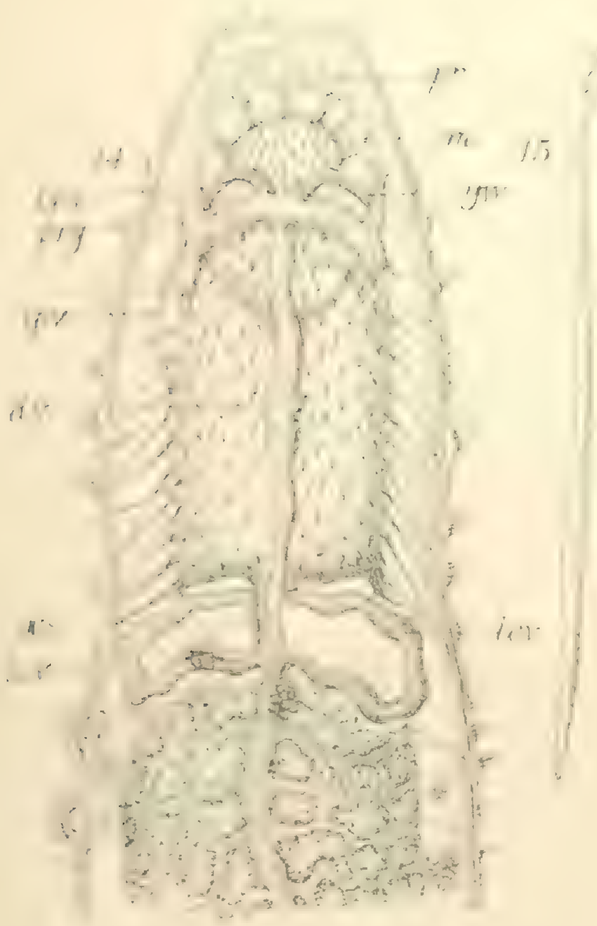
lcv

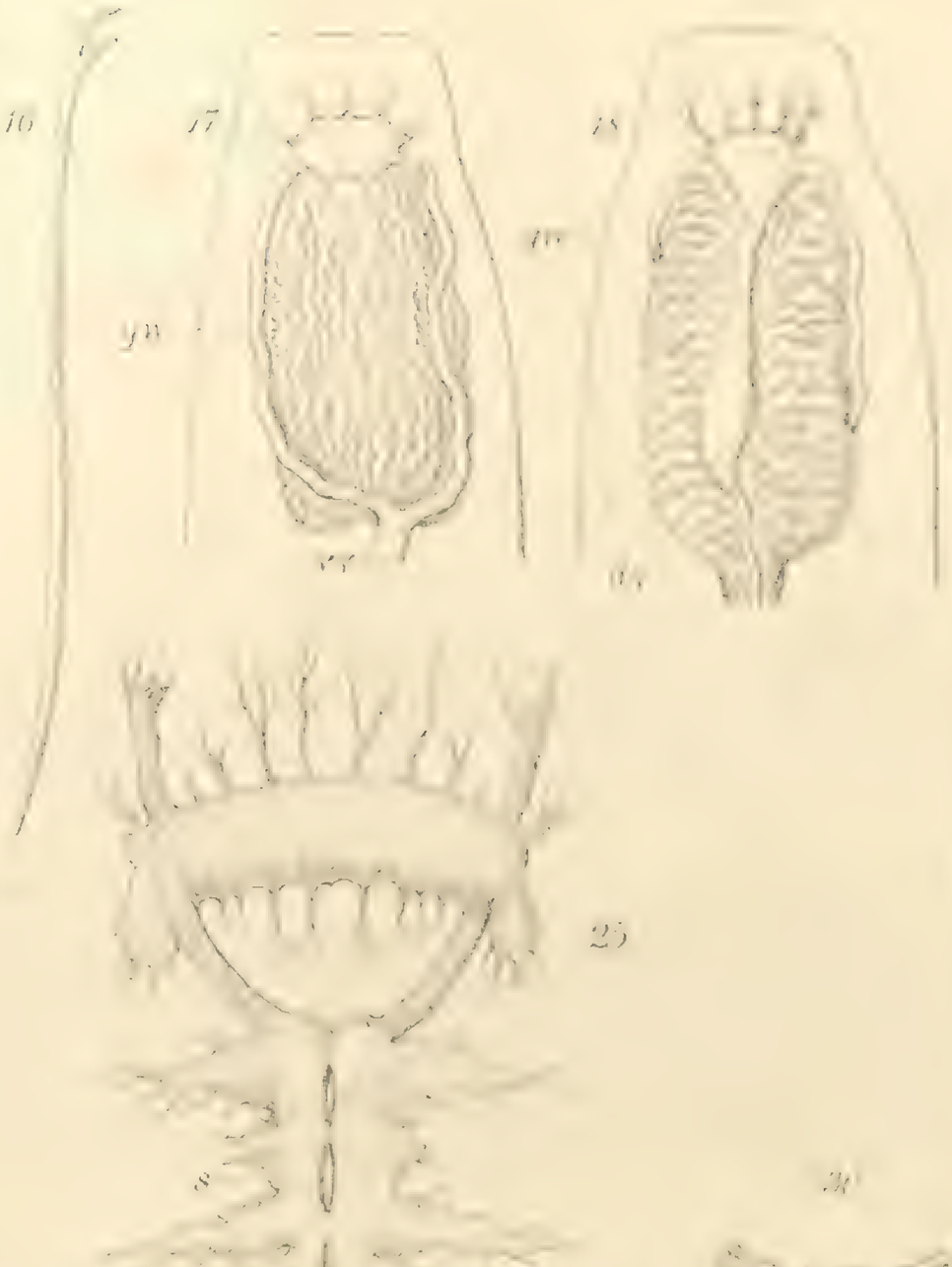
st

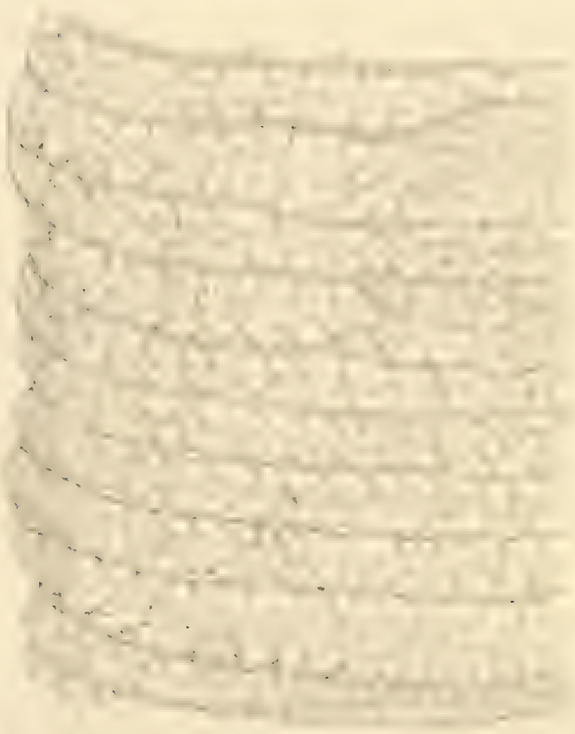
1sq

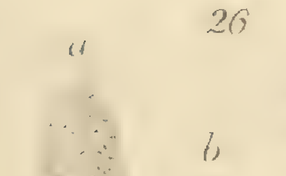
12

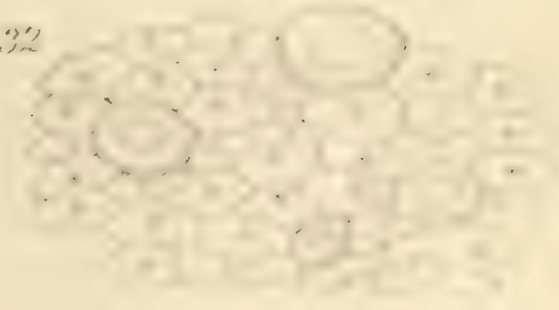
Wilson sc.

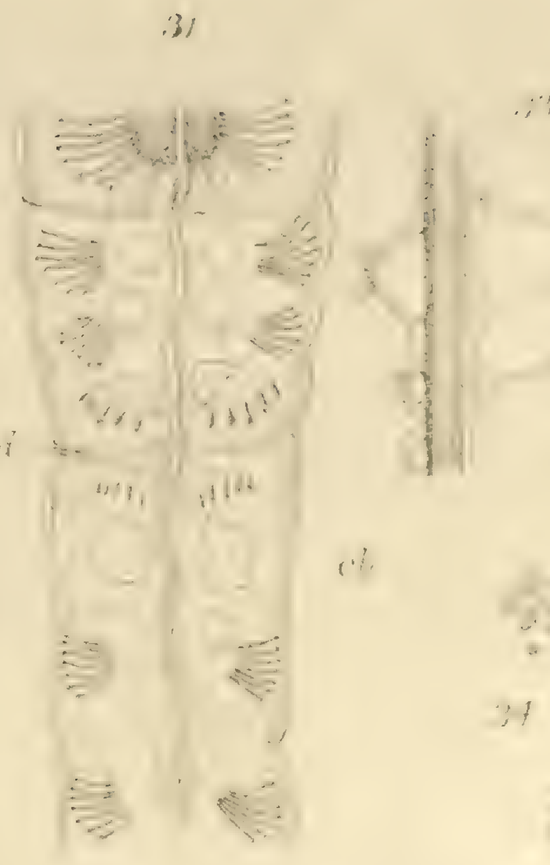


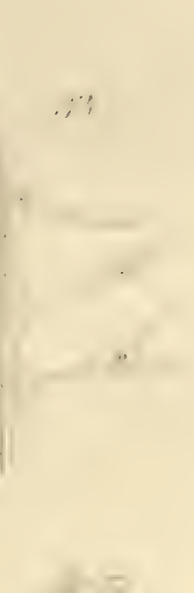


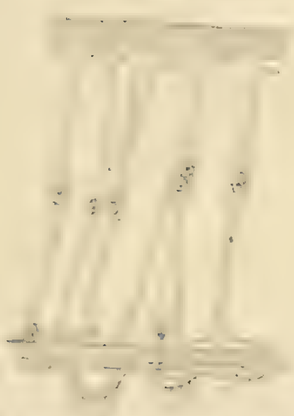












XV. *On the Variations of the angular divergencies of the Leaves of* Helianthus tuberosus.

By the Rev. George Henslow, *M.A., F.L.S.*

(Plate L.)

Read April 16th, 1868.

THE angular divergences of leaves and their homologous appendages, as represented by the different fractions of the well-known series, are for the most part tolerably constant; but it sometimes happens that in following the leaves spirally up a stem, we find vertically over the leaf selected as the first a different one from that which we should have expected. That cycle, therefore, must be represented by a different fraction to the one preceding.

Again, in continuing our observations from the point last reached, we find perhaps the same number of leaves after the same number of revolutions in the third cycle as in the first; or, on the other hand, the leaf in the same vertical line may be found only after an additional number of revolutions, and the cycle which ends at that point will accordingly be represented by a higher fraction of the series.

Again, if any number of stems on which the leaves are very numerous and their internodes short, or of cones on which the scales are very crowded, be taken, and we attempt to make out the angular divergences of their generating spirals, difficulties frequently arise—partly because the growth of the leaves or scales may not be exactly the same throughout, partly in consequence of some slight torsion of the axis, or from some unaccountable cause, independently of the fact that the generating spirals of cones very frequently belong to some curviserial form*; so that we may be at a loss to select the leaf or scale placed actually, or even nearly, vertically above the one selected below, especially as in many cases the spiral does not admit of strict verticality.

In examining the arrangements of the leaves on about eighty stems of the Jerusalem Artichoke, I found a very considerable amount of variation. The following divergencies were especially common:—

$\frac{2}{5}$ occurred on about	....	28 per cent.†	of the stems	examined.
$\frac{3}{8}$ „	„	40 „	„	„
$\frac{2}{7}$ „	„	23 „	„	„
A decussate arrangement	47	„	„	„
$\frac{2}{5}$ throughout the stem	.. 11	„	„	„
$\frac{3}{8}$ „	„	12 „	„	„
A tricussate‡ arrangement	15	„	„	„

* *Curviserial* divergences are those, for the most part, represented by the higher fractions of the series, *e.g.* $\frac{8}{21}$, $\frac{13}{34}$, &c., whose denominators are irrational, or no measure of the circumference.

† *i.e.* for one, two, or more cycles only.

‡ I adopt the word "tricussate" for whorls of three leaves each, in which the leaves of each whorl alternate with those of the whorls above and below it.

In endeavouring to trace the transitions which so frequently occurred in the stems from one kind of divergence to the other, I met with some which were new to me. Thus $\frac{2}{7}$ was, as given above, by no means uncommon; another was $\frac{3}{11}$; and occasionally an approximation to $\frac{1}{4}$ and $\frac{5}{18}$ appeared. Now these fractions can manifestly be arranged into a series analogous to the usual one, viz.:—

$$\frac{1}{4}, \frac{2}{7}, \frac{3}{11}, \frac{5}{18}, \text{ \&c.};$$

where we see at once, by comparing them with

$$\frac{1}{3}, \frac{2}{5}, \frac{3}{8}, \frac{5}{13}, \text{ \&c.},$$

that while they retain the same numerators, the denominators of the successive fractions of this secondary series consist of the sum of the numerators and denominators of the corresponding fractions of the first or primary series, as I propose to call it.

I must here observe that the primary series arises from a fact which appears to be a very important one, and, as far as I am aware, has not hitherto been noticed, *i. e.* that every coil of the helix commencing with the position of any leaf, contains two other leaves beside the initial one. Thus, referring to fig. 1, if we start from leaf No. 1, No. 4 is not reached until after the coil has been completed, on arriving at the vertical line through the initial leaf; similarly, commencing with No. 4, No. 7 is found to be in the next coil; so that no such coil ever contains more than three leaves.

In the secondary series every such coil will contain four leaves. The same numerators are retained for the corresponding fractions of both series, as they represent the number of coils in each cycle, and they are not altered by the number of leaves being increased in each coil.

In a similar way it may be seen that tertiary, quaternary, and other series might be deduced, in which each coil will contain five, six, or more leaves successively. And, further, the following algebraical expressions will represent every series of divergence.

Let a be any number; then the fractions

$$\frac{1}{a} \quad \frac{1}{a+1} \quad \frac{2}{2a+1} \quad \frac{3}{3a+2} \quad \frac{5}{5a+3} \quad \frac{8}{8a+5}, \text{ \&c.}$$

are quite general, and will include the angular divergences of all generating spirals.

They are based upon the principle that any portion of the spiral subtending 360°, *i. e.* a single coil of the helix as above described, contains $a+1$ leaves. To each series there is an initial fraction, viz., to the primary $\frac{1}{2}$, to the secondary $\frac{1}{3}$, to the tertiary $\frac{1}{4}$, &c., which must be exempted from the foregoing remarks, as the leaves in a projected coil of the spiral corresponding to these fractions are but two, three, four, &c., respectively. It will be hereafter shown how these initial fractions are the connecting links between the several systems or series of divergences *.

* Since discovering the existence of other series than the primary amongst the leaves of *Helianthus tuberosus*, and thence deducing the algebraical formulæ to represent all divergences, I have found, by referring to MM. Martin and Bravais's *résumé* of MM. Schimper and Braun's researches on Phyllotaxis (Ann. des Sc. Nat. 2me sér. vii. 1837), that much the same expressions have already been suggested from independent sources. It is, however, I think, interesting to find that a single species has so many variations of arrangement that it alone has afforded the means of arriving at very considerable generalizations.

On the Transitions from one kind of divergence to another of the same or of different series.

On referring to the diagram (fig. 1.) of the divergence $\frac{8}{21}$ of the primary series, it will be seen that in consequence of no projected coil, as described above, containing more than three leaves, the angular divergences of all the spirals of these series will necessarily lie between 120° and 180° inclusive, or those represented by $\frac{1}{3}$ or $\frac{1}{2}$, and particular numbers will arrange themselves right and left, and nearest to the assumed vertical line corresponding to any generating spiral. Thus, for the fraction $\frac{8}{21}$, two numbers in close proximity to this line, and situated below the 22nd leaf (which commences the second cycle), are the 9th and 14th. These, together with the initial leaf selected as No. 1 of the generating spiral, form the commencement of two secondary spirals through the numbers 1, 9, 17, 25, 33, 41, &c., and 1, 14, 27, 40, &c., the angular divergences of which, *as generating spirals*, would be represented by the fractions $\frac{3}{8}$ and $\frac{5}{13}$ respectively. Hence it can be seen that by shifting, as it were, the 22nd leaf to the one side or the other, some other leaf will fall exactly or approximately over the first, and the generating spiral will no longer be represented by $\frac{8}{21}$, but by some other fraction. And as the leaves nearest to the vertical line passing through the 1st and 22nd leaf are those which commence the second cycles of spirals, represented by fractions $\frac{5}{13}$ on the one hand, and $\frac{13}{34}$ on the other, these are found to be the divergencies into which $\frac{8}{21}$ would most readily pass.

Similarly, if a vertical line be drawn corresponding to the $\frac{5}{13}$ divergence, by a slight movement to the left (suppose), the 22nd leaf comes most nearly over the first, and the spiral arrangement of $\frac{8}{21}$ is obtained; but if a greater displacement to the right had taken place, the 9th leaf would have fallen over it; or, again, by a still greater displacement to the left, the sixth will be vertically over the first; and we thus pass into the arrangements for the generating spirals represented by the fractions $\frac{3}{8}$ and $\frac{2}{5}$ respectively.

Exactly analogous results can be obtained from the secondary and other series of fractions; for if we select the line passing through the 1st and 19th leaves, or the vertical line for the divergence $\frac{5}{18}$, we can, by supposing a slight deviation to the right, bring the 29th leaf over the 1st, so that the generating spiral would now become $\frac{8}{29}$. Likewise by a deviation to the left the 12th leaf would arrive over the first, and a transition be thus obtained into the divergence $\frac{3}{11}$; or, if we had first chosen the vertical for this arrangement, *i. e.* a line through the 1st and 12th leaves, then it is easy to see how a change can be effected, either into the lower members of the series $\frac{2}{7}$ or $\frac{1}{4}$, or to the higher one $\frac{5}{18}$.

Generalizing these remarks, it becomes clear that similar transitions can be presumed possible in all other series, and, further, that any one series can pass into another, provided it be represented by a generating spiral, the angular divergence of which is a low one in that series, *i. e.* either itself being one of the divergences $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, &c., or capable of passing into one of them, as, from these, passages may be presumed possible from the primary into the secondary, secondary into tertiary, and *vice versâ* respectively, inasmuch as each of these fractions is common to two series.

On the Methods of ascertaining the Numerator and Denominator of Fractions representing generating spirals of all series.

In order to find the numerator and denominator of the fraction representing a generating spiral, where the leaves or scales are so crowded that it cannot be readily discovered by inspection alone, the usual rules are as follows:—Either to affix*, first of all, the proper numbers to each scale, and then observe that which falls upon the scale vertically over the first, and which, lessened by 1, gives the denominator; while, to find the numerator, the axis must be allowed to revolve, when the number of revolutions made in passing from No. 1 to the scale over it will give it. Or, if we take the common differences corresponding to the two secondary spirals which pass through the scale selected as No. 1, and also the scales *nearest to, but immediately below*, the scale vertically over the first, the sum of these common differences supplies the denominator, and the smaller of them the numerator.

The former of the two methods will apply to any spiral of any series. The latter rule, though of application in the primary, fails to give the *numerator* for any divergence other than those included in that series; but if it be remembered that the numerators are respectively the same for the corresponding fractions of every series, no great difficulty will be met with in affixing the right one to any denominator. This arises from the fact that the number of coils in a cycle is the same for all such fractions, the real difference being in the number of leaves in a coil. Thus $\frac{3}{8}$, $\frac{3}{11}$, $\frac{3}{14}$, are the third fractions in the primary, secondary, and tertiary series, in which each coil of a cycle has 3, 4, 5 leaves respectively.

The fact of each coil having the same number of leaves, whatever arrangement be taken (provided it be from one and the same series), appears to be a very important principle, and hitherto, I believe, overlooked. Yet it is mainly† upon this fact that all calculations are really based. That this is the case will be understood from the fact that if any spiral of the primary series, by a diminution of the angular divergence, were to possess four leaves in a single coil, it would become a member of the secondary series. Similarly, if a spiral of the secondary series shall possess five leaves in any of its coils, it will pass into the tertiary series.

On certain Relations between the Fractions of the several Numerical Series.

It has been already noticed that the sum of the numerator and denominator of any fraction in one series forms the denominator of the corresponding fraction in the next series; thus, if they be written down as follows,

Primary series . . .	$\frac{1}{2}$,	$\frac{1}{3}$,	$\frac{2}{5}$,	$\frac{3}{8}$,	$\frac{5}{13}$,	$\frac{8}{21}$,	$\frac{13}{34}$,	&c.,
Secondary series . .	$\frac{1}{3}$,	$\frac{1}{4}$,	$\frac{2}{7}$,	$\frac{3}{11}$,	$\frac{5}{18}$,	$\frac{8}{29}$,	$\frac{13}{47}$,	&c.,
Tertiary series . . .	$\frac{1}{4}$,	$\frac{1}{5}$,	$\frac{2}{9}$,	$\frac{3}{14}$,	$\frac{5}{23}$,	$\frac{8}{37}$,	$\frac{13}{60}$,	&c.,

* It is assumed that the reader is familiar with the method usually given in elementary text-books.

† It must be remembered that as the position of any 2nd leaf of a spiral of the primary series has a range of 60° for its position, viz. from 120° to 180°, in other words, all angular divergences of that series lie between $\frac{1}{3}$ and $\frac{1}{2}$ inclusively, there must be some "innate guiding principle" (for want of a better expression till the cause be discovered) which gives these second leaves a tendency to stay at certain points within that range, and corresponding to the successive convergents of the primary series, the limiting point being at an angle of 137° 30′ 28″.

it will be at once seen that 5+2, or the sum of the denominator and numerator of the third fraction of the primary series supplies the denominator 7 to the third fraction of the secondary series, and so on.

Next, it may be observed that the same connexion which has been long noticed in the primary series holds good also for all others, viz., the sum of the denominators of any two adjacent fractions is the denominator of the next succeding, *e. g.* 7+11=18, &c.

Again, it has been noticed that in the primary series any numerator is the same number as the denominator of the fraction *next but one* preceding it. Now this relation cannot be maintained in any other series; but if it be remembered that the denominators can be formed by adding the numerator and denominator of the corresponding fraction of the preceding series, the true and general relation at once appears, as in the following examples:—

The denominator of the fraction $\frac{3}{8}$ supplies the numerator to the fraction $\frac{8}{21}$; but in the secondary series the denominator is 11(=8+3); so also in the tertiary series the denominator of the corresponding fraction is 14(=11+3=8+2×3). Hence it appears that the fourth fractions might be arranged as follows:—$\frac{3}{8}$, $\frac{3}{8+3}$, $\frac{3}{8+2\times3}$, $\frac{3}{8+3\times3}$, &c.

Generalizing from this observation, if $\frac{a}{b}$ represent any fraction of the primary series, $\frac{a}{b+a}$, $\frac{a}{b+2a}$, $\frac{a}{b+3a}$ will represent the corresponding fractions of the secondary, tertiary, and quaternary series respectively.

Lastly, MM. Schimper and Braun have shown that the fractions of these series are the successive convergents of the continued fractions $\frac{1}{2+}\ \frac{1}{1+}\ \frac{1}{1+}$ &c., $\frac{1}{3+}\ \frac{1}{1+}\ \frac{1}{1+}$ &c., $\frac{1}{4+}\ \frac{1}{1+}\ \frac{1}{1+}$ &c., the limiting values of which are represented by $\frac{3-\sqrt{5}}{2}$*, $\frac{5-\sqrt{5}}{10}$, $\frac{7-\sqrt{5}}{22}$, &c., respectively, which, when multiplied by 360°, give the angles 137° 30′ 28″, 99° 30′ 6″, 77° 57′ 19″ as the limiting angular divergences for the first three series respectively. [*Vide* Ann. des Sc. Nat. 2me sér. vii. 1837.]

ILLUSTRATIONS OF THE TRANSITIONS FROM ONE DIVERGENCE TO ANOTHER AMONGST THE LEAVES OF HELIANTHUS TUBEROSUS.

I. *Transitions from the Decussate arrangement into Spirals of the Primary series.*

The stems, the leaves of which commence at the base in a decussate manner, had, on the average, seven pairs of opposite leaves placed alternately at right angles to each

* The method of obtaining this result will be understood from the following:—

let $x=\frac{1}{1+}\ \frac{1}{1+}\ \frac{1}{1+}$ &c., and $y=\frac{1}{2+x}$;

from the equation $x=\frac{1}{1+x}$ we obtain $\frac{\sqrt{5}-1}{2}$ as the value of x,

and therefore $y=\frac{2}{\sqrt{5}+3}=\frac{3-\sqrt{5}}{2}$.

other; but above them the leaves gradually assumed some spiral form by *shifting* to the right or left (*i. e.* of the observer in front).

i. No instance of a direct change from opposite leaves into the $\frac{1}{3}$ arrangement presented itself; indeed, to accomplish this, the divergence would have had to pass from one limit to the other, *i. e.* from 180° to 120°.

ii. The change from the decussate into the $\frac{2}{5}$ divergence occurred not unfrequently. The method by which it was effected will be understood by reference to the diagram (fig. 2), in which it will be observed that the positions of the leaves numbered 1 and 2 are not strictly opposite, and that radii drawn from them to the centre do not pass at right angles to the diameter through the asterisks which indicate the position of the highest pair of opposite leaves; so that these radii include an angle of about 150°. Again, by a similar approximation of the 3rd and 4th, and of the 5th and 6th leaves, we find, on completing the second turn of the spiral, that the 6th leaf is over the first; so that a transition into the $\frac{2}{5}$ divergence has been established from this point.

It must be noted that the angles between the radii drawn from the centre through successive leaves of this first, and of what might be called *transitional* cycle, do not accurately equal 144° or $\frac{2}{5}\times360°$, as indicated by the dotted radii. But as the spiral arrangement is continued up the stem and into the terminal bud, the leaves seem to "right" themselves, as it were; so that the appearance of the spiral in the neighbourhood of the summit is more accurate than at the point of departure from the highest pair of opposite leaves.

iii. In a similar manner to the above, direct transitions into the $\frac{3}{8}$ arrangement occurred quite as often as into the $\frac{2}{5}$, the only difference being that the angle included between radii drawn to the pair of leaves which converge to one side is less than 150°, —indeed, nearly, if not quite accurately, 135°, which is the angular divergence of the $\frac{3}{8}$ arrangement.

iv. Only one instance occurred where opposite leaves were resolved in a similar way directly into the $\frac{5}{13}$. When this fraction was otherwise represented, it was due to a slight shifting of the leaves in the cycle following upon one or more preceding cycles of the $\frac{3}{8}$ divergence.

II. *Transitions from the Decussate arrangement into Spirals of the Secondary series.*

i. No instance of a direct transition from the decussate into the $\frac{1}{4}$ arrangement presented itself*.

* Although two pairs of decussate leaves are at right angles to each other, and therefore, if projected on a plane, have an angular divergence of 90°, or $\frac{1}{4}$, yet, if the internodes be developed, the order of the leaves could not be such as is required for the $\frac{1}{4}$ arrangement, but would be thus,—

2
5
3 8 7 4
6
1

Although no such transition occurred with decussate leaves, this process was frequently illustrated in the breaking up of tricussate leaves, as will be shown hereafter.

ii. A transition from opposite leaves into the $\frac{2}{7}$ occurred in about 15 per cent of those stems commencing at the base with decussate leaves. It can apparently only be effected by some previous approximation to the "tricussate" grouping of leaves. The process will be best understood by referring to the diagram (fig. 5), which illustrates the actual position as observed in nature; in which it will be noticed that, from the 1st to the 9th leaf, the spiral is to the left, and that, in consequence of the 8th and 9th leaves becoming confluent, the latter is ranged over the first, while the 10th becomes nearly opposite and is over the second. From this point (the 10th leaf) the spiral turns to the right, and, by the 14th and 15th, the 17th and 18th, becoming confluent, the 17th leaf is over the 10th, and thus the $\frac{2}{7}$ arrangement is commenced, and henceforth continued uninterruptedly into the undeveloped terminal bud.

A more usual way, however, of passing from opposite leaves into the $\frac{2}{7}$ arrangement is by throwing out an extra leaf at right angles to the diameter passing through them (fig. 6), and by converging the first pair towards the opposite side, and in this manner exhibiting a tendency to produce a whorl of three leaves, and consequently four in any single coil commencing with the position of some leaf. A point to be observed in this method is, that if the confluent pair be exactly on the same level, either one may be taken as the second leaf of a cycle commencing with the first isolated leaf. Thus the 8th or 9th leaf will be immediately over the 1st, according as the spiral is chosen to one side or the other, corresponding to the divergences $\frac{2}{7}$ or $\frac{3}{8}$ respectively. The leaves of each confluent pair generally become isolated at last, one being elevated above the other, so that a true spiral is ultimately secured.

It must be observed that the same angular distance between the two confluent leaves answers for two kinds of spiral, viz. $\frac{2}{7}$ and $\frac{3}{8}$. This is of course, strictly speaking, impossible, as the angular divergence for $\frac{2}{7}$ is $102° 51' 77'' +$, and for $\frac{3}{8}$, $135°$; but this condition is only transitional. When the leaves become isolated the proper angular divergence is subsequently secured, and is generally $\frac{2}{7}$.

iii. The next fraction of the secondary series is $\frac{3}{11}$. This was only occasionally represented, with a commencement of decussate leaves at the base of the stem, by a previous transition into the $\frac{2}{7}$ spiral—and by the "vertical" line passing through the 1st, 8th, and 15th leaves being itself really inclined, and so forming a secondary spiral, in consequence of which the 12th leaf falls approximately over the 1st.

iv. In like manner $\frac{5}{18}$ was occasionally reached by a passage through $\frac{3}{11}$ and $\frac{2}{7}$.

III. *Transitions from the Tricussate arrangement into Spirals of the Primary series.*

i. Three verticillate leaves were never resolved directly into the $\frac{1}{3}$ arrangement; yet in certain stages of change it occasionally happened that a 4th leaf would fall nearly over another selected as the 1st. Similarly no case appeared of a direct transition into the $\frac{2}{5}$ arrangement. Indeed it appears that tricussate verticils are more readily resolvable into spirals of the secondary series, just as decussate leaves are most readily convertible into those of the primary.

ii. The diagram (fig. 7) will illustrate the manner of transition from tricussate leaves into the $\frac{3}{8}$ divergence, a change which occurred in about 30 per cent. In this case the

3rd leaf is isolated; but the 2nd, though still confluent with the 1st (as indicated by the thickened line in the fig.), is slightly raised. Similarly the 5th, though united to the 4th by the broad base of the petiole, is at a slightly higher level. The same remark applies to the 8th; but the internode between the two confluent leaves, the 7th and 8th, is now much increased. Above the 8th the leaves are entirely free; and finally the 9th is vertically over the 1st, so that the $\frac{3}{8}$ divergence is established.

IV. *Transitions from the Tricussate arrangement into Spirals of the Secondary series.*

i. No direct change from tricussate into $\frac{1}{3}$ or $\frac{1}{4}$ occurred.

ii. A change from verticils of threes into the $\frac{2}{7}$ was frequent. It takes place in the following manner:—The 1st step is to cause the three leaves of the different whorls to separate slightly by a development of their internodes. Then, if any two consecutive whorls be examined, the order of succession of the six leaves (No. 1 being the lowest leaf) is thus,—

6
3 7 9 2
8
4 5

1

in which it will be noticed that the 4th leaf, instead of being over the interval between the 1st and 2nd, is over that between the 1st and 3rd; so that the angle between the 1st and 2nd leaves, or between the 2nd and 3rd, is *double* that between the 3rd and 4th. These latter, it will be remembered, are separated by a long internode. The same order obtains with the succeeding whorls; the nodes, however, are now much more widely separated, while a true spiral arrangement, with the same angular distance between all its leaves, is ultimately secured, and is henceforth continued uninterruptedly into the terminal bud, and represented by the fraction $\frac{2}{7}$.

Another method of separation of the three leaves of the whorls consists in one leaf only becoming isolated (as was the case in the transition from tricussate into $\frac{3}{8}$ divergence), while the other two remain coherent at the same level. The result obtained in this case, it will be remembered, is identical with that secured in certain cases of change from decussate leaves, where a *third* leaf is thrown out at right angles to the diameter passing through the supposed original positions of the opposite leaves, which now converge to one side. From this stage either of the two following results may occur:—On the one hand, by the ultimate separation of the two confluent leaves, the $\frac{2}{7}$ spiral is secured (as described in the case of the passage from decussate leaves into that divergence), or, on the other hand, the two confluent leaves may never separate at all, so that a repetition of two coherent and one single leaf occurs up the stem to its summit.

iii. Although the $\frac{2}{7}$ arrangement is by far the most general of the secondary series, as arising from the tricussate, yet other divergences occasionally occur with more or less accuracy. The diagram (fig. 8) illustrates a case in which $\frac{3}{11}$ commenced with the 18th leaf, in having the 24th almost accurately above it, which divergence was maintained henceforth uninterruptedly into the terminal band*.

* In the résumé of MM. Schimper and Braun's work on "Phyllotaxis," by MM. Bravais and Martin, these authors

V. *Transitions from Divergences of the Primary to those of the Secondary series.*

Transitions from one series to another upon the same stem do not appear to be readily effected. It rarely if ever occurs amongst the spirals of the *Helianthus* without some intermediate verticillate (either actual or approximate) arrangement.

If it be remembered, however, that for the primary series all divergences lie between 120° and 180° inclusively—for the secondary series, between 90° and 120°—and for the tertiary between 72° and 90°, it will be seen that to pass from the primary to the secondary the angle must be as near 120° as possible, or that represented by $\frac{1}{3}$. Now as this fraction is common both to the primary and secondary series, *we can conceive* of a passage from one series to another through that divergence. Similarly through $\frac{1}{4}$, or 90°, a passage could be effected from the secondary to the tertiary. Hence the series $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, &c., would be the fractions indicating what might be called transitional divergences.

Such, however, was not the method obtaining amongst the leaves of *Helianthus tuberosus*.

The diagram (fig. 8) illustrates an instance where the leaves at the base of the stem were arranged for the first cycle according to the $\frac{2}{5}$ divergence (primary series) and revolving to the right. In consequence, however, of some misplacement in the second cycle, the 9th leaf fell over the 6th, *i. e.* the 1st leaf in that cycle, which must therefore be represented by $\frac{1}{3}$. In the third cycle there was a return to the $\frac{2}{5}$, as shown by the 14th leaf being over the 9th. In this cycle the 11th and 12th, as also the 14th and 15th in the next, became confluent, indicating therefore an attempt at a verticillate grouping. The 16th, 17th and 18th leaves were free, and, though distant about 120° from each other, were not at the same level. From this point a sudden change to two perfect whorls of three each occurred. Then a new spiral (of the secondary series) abruptly followed, revolving to the left, and containing four leaves in each coil, starting from No. 1 (*bis*). Of this spiral the first two leaves most nearly in the same vertical line were the 13th and 24th; and as there were three coils between them, the angular divergence now represented by the leaves was $\frac{3}{11}$. No further change occurred up the stem.

I may here mention that MM. Bravais and Martin observe that when transitions occur from one series to another, it is by nature selecting, as it were, for the change a new denominator as nearly the same as possible to the preceding; thus $\frac{3}{14}$ (in the tertiary series) may be followed by $\frac{5}{13}$ (in the secondary series). They, however, do not cite an example; and I would add that I met with no such instance; for in the *Helianthus* the change was almost invariably effected by an intermediate (either actual or approximate) verticillate arrangement.

The following examples will illustrate the principal cases of change from one kind of angular divergence to another on the same stem:—

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notice the occurrence of changes from verticils to spirals and *vice versâ*. They state that if two different whorls have an intermediate spiral by which they are connected, then the fraction representing this spiral will be an arithmetic mean between the divergences of the whorls. Thus if a whorl represented by $(\frac{1}{6})$ be connected with a whorl of $(\frac{1}{5})$, the intermediate spiral will be known by $\frac{2}{11}$. They do not mention individual cases. (Ann. des Sc. Nat. 2^{me} sér. viii. p. 170.) No such arrangement appeared amongst the leaves of the *Helianthus*.

I. Commencing with a decussate arrangement (D) at the base of the stem :—

1.	D	into	$\frac{2}{5}$	into	$\frac{3}{8}$	into	$\frac{2}{5}$
2.	,,	,,	$\pm\frac{2}{5}$*	,,	$\pm$T	,,	$\frac{2}{7}$
3.	,,	,,	$\frac{3}{8}$	,,	$\frac{2}{5}$		
4.	,,	,,	$\frac{3}{8}$	,,	$\frac{2}{7}$		
5.	,,	,,	$\frac{3}{8}$	,,	$\frac{2}{7}\pm\frac{1}{4}$	into	$\frac{2}{7}$
6.	,,	,,	$\pm\frac{3}{8}$	,,	$\pm\frac{5}{13}$		
7.	,,	,,	$\frac{5}{13}$	,,	$\frac{3}{8}$		
8.	,,	,,	(2+1)†	,,	$\frac{3}{8}$		
9.	,,	,,	(2+1)	,,	$\frac{2}{7}$		

II. Commencing with a tricussate arrangement (T) at the base of the stem :—

1.	T	into	$\frac{3}{8}$			
2.	,,	,,	$\pm\frac{1}{4}$	into	$\frac{2}{7}$	
3.	,,	,,	$\frac{2}{7}$			
4.	,,	,,	$\frac{3}{11}$	into	$\frac{2}{7}$	
5.	,,	,,	(2+1)	,,	$\frac{2}{7}$	

III. Commencing with an alternate arrangement at the base of the stem :—

1.	$\frac{1}{3}$	into	$\frac{3}{8}$	into	$\frac{5}{13}$	into	$\frac{3}{8}$
2.	$\frac{2}{3}$	,,	$\frac{3}{8}$				
3.	$\frac{2}{5}$	,,	$\frac{3}{8}$	,,	$\frac{2}{5}$		
4.	$\frac{2}{5}$	,,	(2+1)				
5.	$\frac{3}{8}$	,,	(2+1)				

Hypothetical Origin of the prevailing series.

By referring to the diagram (fig. 9) it will be seen that the angular distances included by the limiting positions of the second leaves of all generating spirals, commencing at 0, decrease according as the spirals belong to the secondary, tertiary, quaternary, &c. series; so also does the number of leaves in a single coil increase correspondingly; and therefore the higher the series the more nearly does any spiral belonging to it approach the verticillate condition, provided the internodes be but slightly developed. Now, if it be true that these higher series were more abundantly represented amongst "fossil vegetables," as M. Decandolle‡ remarks, or if, as Mr. Haughton§ says, the verticillate arrangements were universally represented, at least by the orders Filices, Equisetaceæ, and Lycopodiaceæ, then we can, I think, have some grounds for at least imagining such arrangements to have been the forerunners of spirals of the lower series, such as of the secondary and primary of the present day. But if we attempt to explain how such

* The symbol (±) indicates "approximately."

† (2 + 1) indicates the case of two confluent leaves together with one single leaf.

‡ "Théorie de l'Angle Unique en Phyllotaxie. Par M. C. DeCandolle" (Archives des Sciences Phys. et Nat. p. 14. 1865).

§ Manual of Geology. By Rev. Sam. Haughton, p. 245.

change came about, it can only be by mere speculation. We might, for instance, imagine that the crowded state of the leaves which must obtain where there is a comparatively large number in the same coil or circle might not be so advantageous to their development as a more scattered condition *. And hence we may be led to think that natural selection may have had some influence in bringing about these changes. We might be induced to speculate still further, and say that the verticillate, including opposite leaves, was the earliest arrangement, and that the spiral condition was a subsequent evolution; while the various changes of divergence of the Helianthus might remind us that it appears much easier to resolve verticils into spirals than to convert spirals into verticils. So, too, if analogy might be brought to bear upon this point, we might think that as "radial symmetry" (as we might call it) is characteristic of a lower organization amongst animals than the bilateral and integrated condition of organs belonging to those of a higher organization, so the multiplication of leaves and their more or less verticillate arrangement, might perhaps hint at an original truth, now well nigh obscured, if not obliterated by the evolution of ages. But putting all such speculations aside, no successful attempt has hitherto been made to ascertain the *cause* of any definite arrangement existing at all. We are quite as unable to explain it as to give a reason why the numbers 5 and 4 prevail among the parts of Dicotyledonous flowers, and 3 among those of Monocotyledons.

So, again, if we limit our inquiries to the condition of the primary series alone, we find, as a fact in nature, that if we assume any leaf as No. 1, then No. 2 lies between 120° and 180° inclusively, and that, too, either to the right or to the left. If we are asked why it is so, we can give no answer. Further, starting with this condition, we find that the position of this 2nd leaf is not *anywhere* along that arc, but that it has an inherent tendency to take up a definite point as its position; and, again, when we compare the positions of all such 2nd leaves in a variety of plants, or, as has been shown, in the *Helianthus tuberosus* alone, we find that the series of points between 120° and 180° affect an approach towards some limiting and intermediate point, which point, however, no known example has ever reached. If we ask, again, why the 2nd leaves endeavour to take up these definite positions and are not anywhere over the arc, there is as yet no answer to this question, any more than to the first. All that appears capable of exact statement is, that such are the conditions found to exist in nature, and that when the angles between the first and second leaves of all the different generating spirals are measured, and represented as fractional parts of the circumference, they are found to bear such relations to one another, when written down in succession, as obtain between the successive convergents of the continued fraction of the general form $\frac{1}{a+}\ \frac{1}{1+}\ \frac{1}{1+}\ \frac{1}{1+}$ &c.

* Perhaps the fact that in many cases where leaves occur either in a verticillate or fasciculate condition, they are not unfrequently more or less inclined to be linear or acicular in form, may give some countenance to this idea; such at least is the case in the following orders and genera:—Coniferæ, Galiaceæ, Equisetaceæ; Hippuris, Callitriche, and Myriophyllum. Conversely, we might imagine a more scattered condition favourable to a greater development of limb.

EXPLANATION OF THE PLATE.

Tab. L.

Fig. 1. Projection of the divergence $\frac{8}{21}$. The arrows indicate the secondary spirals, $\frac{5}{13}$ to the right, and $\frac{3}{8}$ to the left.

Obs. The numbers in each figure indicate the position of the leaves.

Fig. 2. This projection shows the method of passing from the decussate condition into the divergence $\frac{2}{5}$. The dotted lines give the true angle (144°) between the first two leaves for this divergence. The number 2 indicates the *actual* position of the second leaf.

Obs. The ** (as also in figs. 3, 4, 5, 6) show the position of the pair of opposite leaves immediately preceding the spiral arrangements.

Fig. 3. Illustration of the usual method of change from the decussate condition into the divergence $\frac{3}{8}$. This is effected, as also shown in fig. 2, by a convergence of two leaves to one side; but the angle at the centre between them is less than in the case of a change to the divergence $\frac{2}{5}$.

Fig. 4. Illustration of a change from the decussate condition into the divergence $\frac{5}{13}$ or $\frac{8}{21}$ approximately.

Obs. In these cases the divergences being irrational, and the 14th or 22nd leaf being at a considerable distance above the 1st, it is somewhat difficult to say which divergence might represent most nearly the generating spiral.

Fig. 5. Illustration of a change,—1st, from the decussate arrangement into the divergence $\frac{3}{8}$, the spiral turning to the left, and terminating with the 9th leaf; secondly, from the 10th leaf the spiral is reversed, is right-handed, and belongs to the divergence $\frac{2}{7}$.

Obs. The thickened portions of the spiral between the Nos. 8 and 9, 14 and 15, 17 and 18, 20 and 21, signify that the leaves corresponding to those pairs of numbers respectively cohere by the expanded base of their petioles. (The same occurs in figs. 6, 7, 8.)

Fig. 6. This diagram illustrates a case where a pair of leaves, above a previously decussate arrangement, have converged to one side. Their supposed original position is indicated by the **. The bases of their petioles remain confluent. A third leaf (No. 1) is *thrown out* on the opposite side, all three being on the same horizontal plane. This process here occurs five times; subsequently the true spiral arrangement of the divergence $\frac{2}{7}$ is eliminated by the development of the internodes.

Obs. 1. As each group of three leaves is on one and the same plane, if the *odd* one be fixed upon as No. 1, it is optional which leaf is selected as No. 2. Hence, if the one to the right be taken as No. 2, the leaf immediately over the first will be No. 8; and the arrangement must be represented by $\frac{3}{8}$. But if the one to the left be chosen as No. 2, then the same leaf immediately over the first will be No. 9; and *this* arrangement must be represented by $\frac{3}{8}$.

Obs. 2. In some cases the ultimate spiral was never eliminated (see fig. 5), but the grouping (2+1), or two leaves united and one free, and all on the same horizontal plane, was continued uninterruptedly to the summit of the stem.

Fig. 7. Diagram to illustrate the change from the tricussate arrangement into the divergence $\frac{3}{8}$. The first three leaves of the spiral are nearly in their original position, the 1st and 2nd being slightly convergent and still coherent. The 4th and 5th, as also the 7th and 8th, likewise cohere respectively; but above the 8th the leaves become entirely free by the development of their internodes, and, the spiral being now eliminated, this arrangement is continued uninterruptedly into the terminal bud.

Fig. 8. This projection represents a case where the leaves commence (at the base of the stem) with the spiral arrangement $\frac{3}{8}$ *to the right*, but for one cycle only; so that the 6th leaf is over the 1st. The next cycle belongs to the divergence $\frac{1}{3}$, by the 9th leaf being over the 6th with one coil

only; but the 14th, after two coils, appearing in the same vertical line, there is a return to the divergence $\frac{2}{5}$. The 11th and 12th, as also the 14th and 15th, leaves cohere respectively. At the 18th leaf the spiral ceases. Then followed two whorls of three leaves each, as shown by the dots. A new spiral *to the left* next commences [from 1 (bis)]; and as the 24th is the first leaf which is found to fall as nearly vertical as possible over any one preceding (viz. 13th), and as there are three coils from 13th to the 24th, the divergence $\frac{3}{11}$ is established, and thenceforward continued upwards without further interruption.

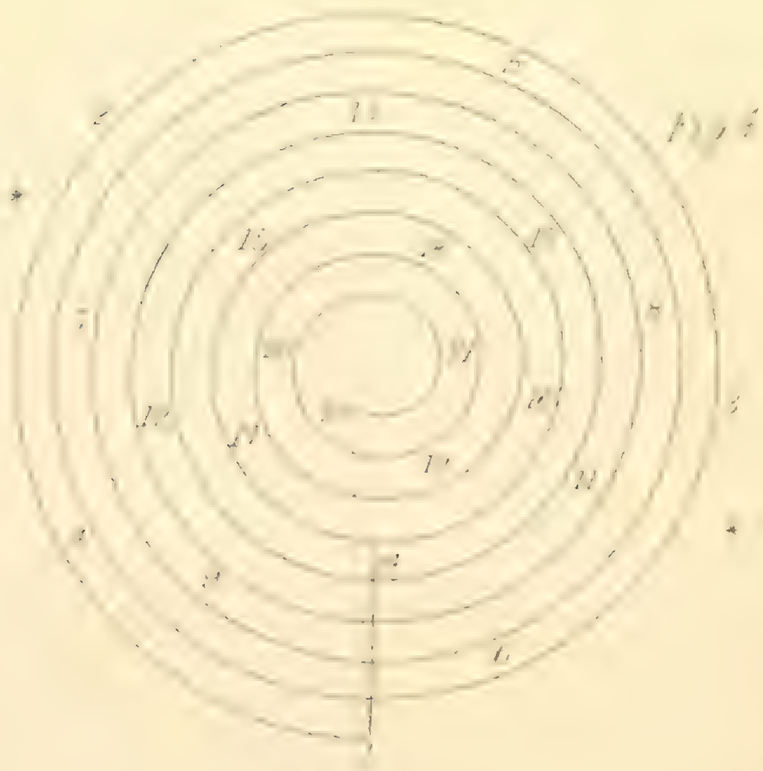
Fig. 9. This diagram illustrates the limiting positions of leaves of spirals corresponding to divergences of the different series.

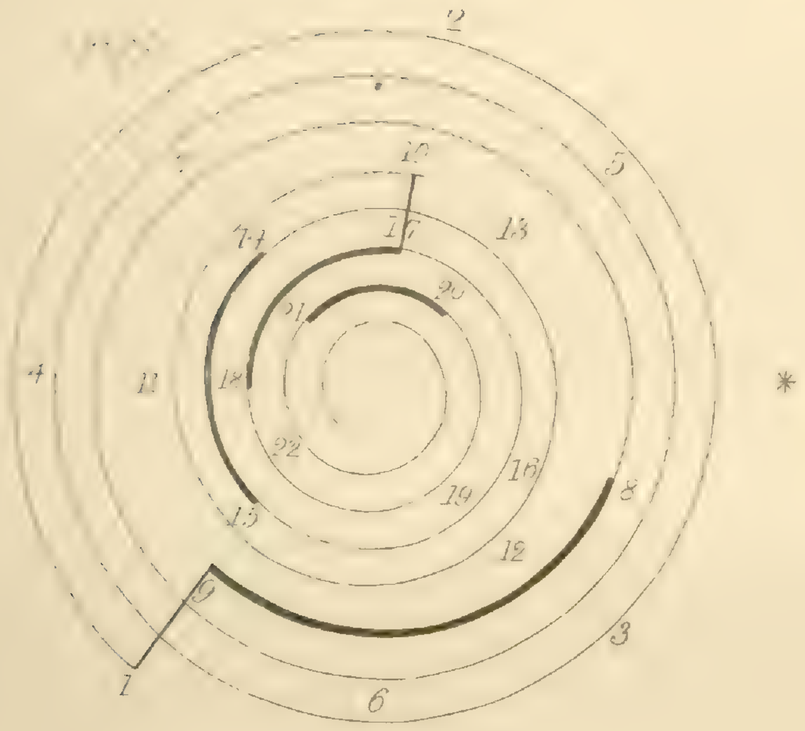
If 0° be the position of any leaf taken as the commencement of any spiral arrangement of the primary series, then the second leaf of that spiral will fall between 120° and 180° inclusively.

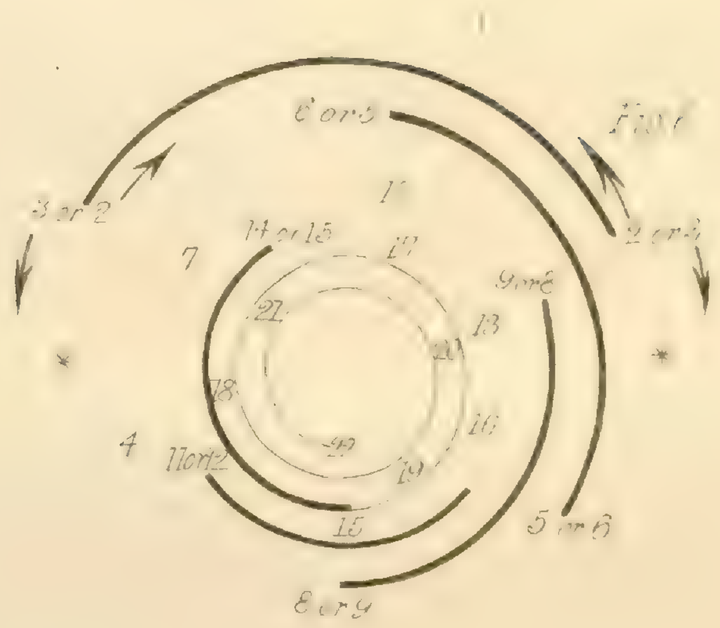
Similarly any second leaf of a spiral of the secondary series falls between 90° and 120° inclusively.

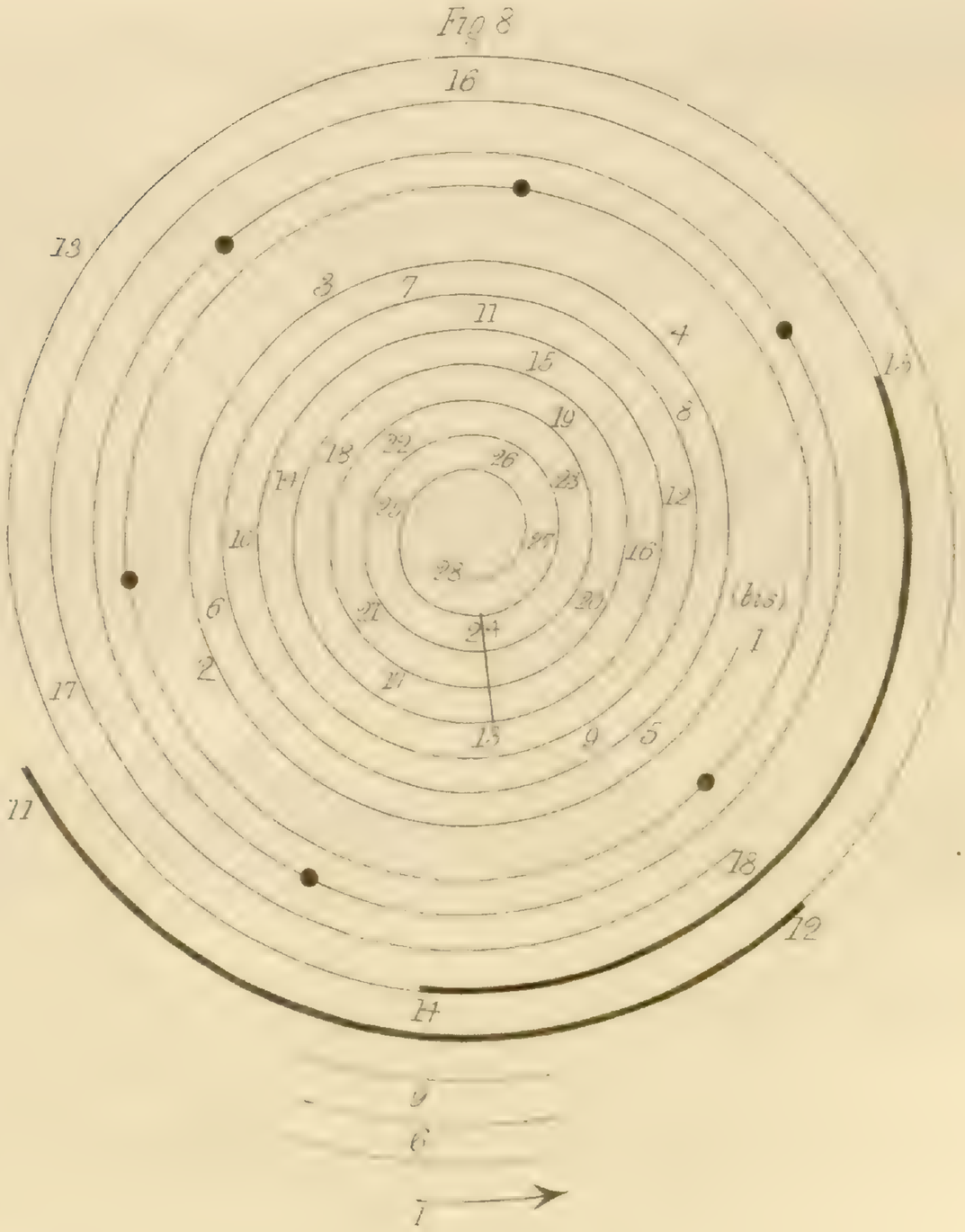
And of the tertiary series any second leaf will fall between 72° and 90°. In a like manner "limiting arcs," as they may be called, can be found for all higher series, which, it will be observed, decrease in size as the No. of the series increases.

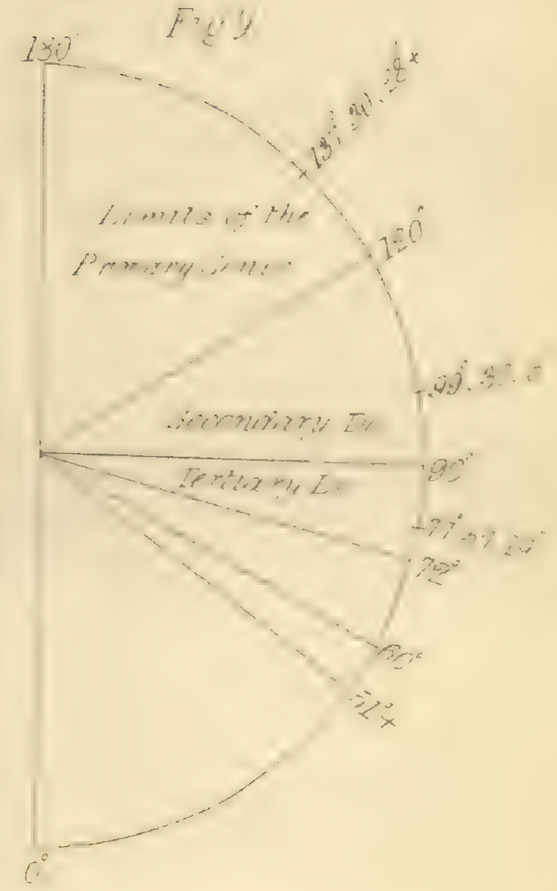
The "limiting angle" to which all divergences of the primary series continuously approximate as they ascend that series is 137° 30′ 28″. The same for the secondary series is 99° 30′ 6″. The same for the tertiary series is 77° 57′ 19″.











Limits of the
Primary Lines
Secondary Lines
Tertiary Lines

XVI. *On Branched Palms in Southern India.* *By* S. Pulney Andy, *M.D., F.L.S., &c.* *Travancore.*

Read November 21st, 1867.

(Plate LI.)

The figures contained in the accompanying Plate represent Branched Palmyra and Cocoa-nut trees, as well as monstrosities of flowers of these Palms, as particularized below.

Plate LI. fig. 1 represents a ramification in Palmyra (*Borassus flabelliformis*) possessing entire branches and four abortive—two on either side.

Fig. 2 represents a ramification in *Borassus flabelliformis*, principally into two, but in one instance into three branches.

Fig. 3 (on the extreme right) represents a dichotomous division in a Cocoa-nut Palm (*Cocos nucifera*). Just above the bifurcation the trunk is narrow, and below it there are two or three holes, caused by the burrowing of insects, by which the original leaf-bud has been destroyed.

The woodcut, fig. 1, represents the flower-stalk of a Cocoa-nut, exhibiting the evolution of vernal leaves from a division of the spadix. The greater portion of the flower-buds in this tree possess this tendency; and the fruits thus formed do not attain to any perfection, but dry and wither away, together with the leaves, within a month after their formation. In each spadix there are, on an average, forty of these shoots of vernal leaves.

Fig. 1.

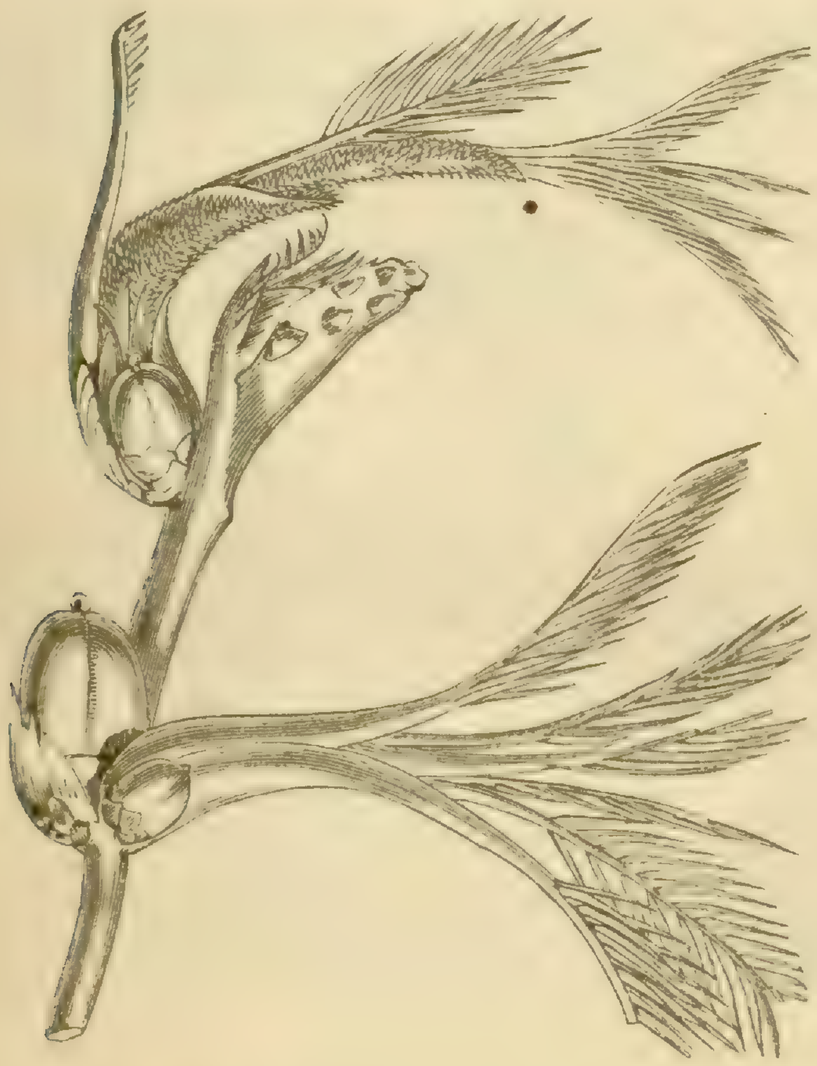


Fig. 2.

Woodcut, fig. 2, represents a monstrosity of a male flower on a Palmyra tree. This is very peculiar and rare. The specimen from which the drawing is taken is kept in a Hindu temple; and it was with great difficulty I was permitted to take the sketch of it.

Ramification in Indian Palms is very uncommon; and the only variety in which this peculiarity is known is in the Doum-Palm of Egypt. Although it appears rather difficult to account for such variation, yet it must be admitted that, without an axillary leaf-bud, from some unknown cause or accident, the ramification could not have originated. It appears to me that the leaf-bud, either from a tendency to duplication or from accidental causes, such as partial destruction of the original leaf-bud by insects, chiefly of the beetle kind, remains inactive until a succeeding one shoots out, when it becomes revived, and thus gives rise to an additional branch. A similar view, I believe, is also prevalent among some intelligent native farmers here with reference to the specimen in Plate LI. fig. 3.

From inquiries, I learn that as many as twelve branches have been observed in the Palmyra, as well as dichotomous division in the Areca-nut Palm. A tree of the latter kind is reported to have been in existence in the town of Trevandrum; and it is only about two or three years ago that it was thrown down during stormy weather.

Twins and triplets amongst Palmyra and Cocoa-nut trees are very common; and I was shown on one occasion a specimen of five shoots of a Cocoa-nut Palm coming out from a single bed, said to be from one seed, and five years old; but they appeared to be about the size of a six months' growth of an ordinary Palm. I offered a good reward to the owner to dig out the plant, to ascertain the truth, but he persistently refused to permit me to do so.

As regards the specimen of a spadix of the Cocoa-nut Palm throwing out the vernal leaves, one is struck with the truth of the flowers being nothing but the modification of leaves; and, in my opinion, the flower-bud cannot, by such metamorphosis, give rise to ramification in a Palm without a true axillary leaf-bud. The fact of the vernal leaves withering away within a month of their formation is in itself a sufficient proof.

However, as my knowledge and researches on the subject are limited, I beg leave to place the matter before the Linnean Society.

W.H. Fitch, del. et. lith.

Fig 2. Fig 1. Fig 3.

THE

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M.DCCC.LXX.

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XVIII. *On Fossil Cycadean Stems from the Secondary Rocks of Britain.* By Wm. Carruthers, *Esq., F.L.S., F.G.S.* 675

XVII. *Contributions towards the History of* Zamia Gigas, *Lindl. & Hutt.** *By* W. C. Williamson, *F.R.S., Professor of Natural History in Owens College. Communicated by* William Carruthers, *Esq., F.L.S.*

Read June 4th, 1868.

(Plates LII. & LIII.)

The rich geological district known as the "Yorkshire Coast" has furnished no more interesting subject for investigation than the *Zamia Gigas*, Lindl. & Hutt. The frond of this plant was first figured in Young and Bird's 'Geological Survey of the Yorkshire Coast' (tab. 2. fig. 6). In Prof. Phillips's 'Geology of the Yorkshire Coast' a few leaflets were given under the name of *Cycadites gramineus* (tab. 10. fig. 2). It was afterwards figured, from one of my drawings, in Lindley and Hutton's 'Fossil Flora' (tab. 165), under the name of *Zamia Gigas*, and I learn from M. Adolphe Brongniart that this represents *Zamia Mantelli* of his 'Prodrome' (p. 199).

In Young and Bird's work some curious fossils are represented whose nature was wholly unknown to the authors; but they suggested that they might be related to the frond already referred to. This suggestion was based upon the fact that the two fossils were found in the same stratum, and not upon a study of their structure; nevertheless it is probably correct.

In 1832 my father drew my attention to some fine specimens of these anomalous objects, which he had just discovered at Hawsker. In 1833 I accompanied him to this locality and succeeded in obtaining additional illustrative specimens, so that, in a memoir presented to the Geological Society of London in May 1834, I ventured to suggest that these organisms were "apparently connected with the fructification of a *Cycas*" (Geol. Trans. 2nd series, vol. v. p. 230). Nothing further was published respecting them, except an imperfect example figured in Mantell's 'Medals of Creation,' until 1847, when two brief notices appeared in the 'Proceedings of the Philosophical Society of Yorkshire,'—one by James Yates, Esq., F.R.S., who has laboured diligently in accumulating specimens illustrative of these Cycads, and the other by myself. In the latter communication several points were specified which further inquiry has confirmed; some others were advanced hypothetically, which I have since found to be either wholly erroneous or to require considerable modification.

More recently I have examined additional specimens in the collections of the Yorkshire Philosophical Society, of the late Dr. Murray and Mr. Bean of Scarborough, and Mr. Ripley of Whitby. Through the latter gentleman I received two invaluable specimens belonging to the Philosophical Society of Whitby, the Council of which Society not only allowed me the use of them, but, with praiseworthy liberality, permitted me to exercise

* I have employed, throughout, the name given by Lindley and Hutton, although Mr. Carruthers has, in a memoir published with this, established for this and the allied species a distinct genus, with which he has done me the honour of associating my name.

my chisel upon them for the purpose of making out some obscure points in their structure, a permission which led to important results. From the specimens thus brought under examination, I have selected the most important; and after describing these individually, I will endeavour, so far as the materials admit, to restore the entire plant. But in attempting this I would carefully distinguish between unquestionable facts and dubious inferences. The facts to which I wish to call attention are reliable. How far my interpretation of them may prove correct remains to be seen.

Amongst the broken débris which falls from the cliffs of Hawsker and Runswick are numerous masses of hard ferruginous sandstone belonging to the "Lower Sandstone and Shale" of Phillips. These masses appear to fall from a stratum about 20 feet thick, which is only separated from the Inferior Oolite by a few feet of carbonaceous shale. The ferruginous blocks furnish the specimens under consideration, associated with Cycadean fronds, fragments of coniferous wood, some ferns, and occasionally an undescribed jointed stem, having the outward aspect of a Calamite; of these, the Cycadean fronds are by much the most abundant; this naturally attracted my attention when endeavouring to discover the complementary parts of the anomalous fossils. To suppose that the latter belonged to a plant of which no other traces had been preserved, was an improbable idea, negatived by their comparative abundance and the small amount of mutilation they had undergone. Such traces could be found only amongst the vegetable remains of the same rocks; of these I have already enumerated the chief. With the ferns they could have no relationship, and with the jointed stem they appeared to have as little. Nothing remained, therefore, but to seek for the missing portions either amongst the coniferous fragments or amongst the Cycadean fronds. All circumstances pointed to the latter as the foliage; but a stem was wanted on which to reunite the detached parts. In 1834 I found, on a huge block of sandstone at Hawsker, the cast of a stem between 1 and 2 feet long and nearly 4 inches in diameter. Its surface was covered with scars resembling those of a Cycad. It had evidently been moulded upon the bark of a tall arborescent plant. The rock was too large for removal, and being unprovided with materials for taking a cast, I could only take a hasty sketch of the specimen and leave it to its fate. Some years afterwards I found in my cabinet a specimen of the sandstone containing a large mass of mingled carbonaceous matter and Scarbroite, and on removing these I found that it had been part of a stem similar to that of which I had so often deplored the loss. Its outer surface exhibited, with great clearness, the rhomboidal scars already referred to, and which closely resembled those of many living Cycadean stems. Having thus obtained two examples of these stems (of which, I may add, Mr. Carruthers informs me he found a third example in the Cambridge Museum), I deemed it probable that they had belonged to the same plant as the Cycadean fronds. On forwarding my specimen to M. Adolphe Brongniart, he replied, "L'empreinte contenue dans cet échantillon me paraît une tige, ou plutôt l'impression d'une petite portion de l'écorce de la tige d'un *Zamia Gigas*. C'est une faite de plus pour compléter l'histoire de cette plante si problématique." This confirmatory opinion, I need scarcely say, left me little room for doubting the correctness of my previous conclusions. From this brief sketch of the history of the subject, I may proceed to describe the specimens.

The Stem.—The exterior exhibited numerous rhomboidal cicatrices left by the fallen fronds. The drawing (Plate LIII. fig. 6) represents a portion of the specimen referred to. The cavity was filled with brown pulverulent carbonaceous matter, mixed with a white aluminous substance (Scarbroite), these being the remains of the solid tissues of the stems, from which all traces of minute structure had disappeared. The surface is divided by a network of elevated ridges into a number of irregular lozenge-shaped spaces, marking the existence, in the original bark, of deep clefts or fissures, separating the base of each petiole from those of its neighbours. Within each area thus circumscribed is a raised oval or diamond-shaped cicatrix, surrounded by a deep depression. This was, of course, reversed in the original, and hence the cicatrix was really one with elevated margins and a depressed centre. On the surface of each cicatrix the cast exhibits, with a considerable degree of uniformity, a deep longitudinal fissure, as well as some oblique but less sharply defined ones towards the upper part. These represent corresponding projections in the stem; but whether they indicate the arrangement of the fibro-vascular bundles or irregularities resulting from accidental contraction, I am doubtful. There are also some other minor but less uniform rugosities on the surface of each cicatrix. In the large example at Hawsker the scars were somewhat larger and further apart than in the specimen figured; its diameter was uniform throughout, like the general habit of *Cycas circinalis* or *C. media*.

In the collection of Mr. Ripley there is a specimen which is obviously the apex of a stem with portions of seven or eight diverging fronds. As these fronds are *in situ*, we have no traces of the cicatrices seen on the lower part of the stem. Its compressed condition, also, has almost obliterated all superficial characters. It confirms, however, what has been already said respecting the elongated contour of the original stem.

Mr. Ripley's cabinet also contains a cylindrical specimen, 4 inches in length, and having a diameter of $1\frac{1}{2}$ inch at one extremity and $1\frac{1}{4}$ at the other, which represents, I believe, the interior of the vascular cylinder. Its surface is marked with numerous interrupted longitudinal grooves and ridges, from half an inch to an inch long, formed by the openings through which the vascular bundles passed to the leaves.

The Fronds.—Soon after leaving the stem the dilated base of each rachis contracts to from $\frac{1}{4}$ to $\frac{1}{3}$ inch, and at a short distance from its origin gives off the small leaflets as in most living Cycads; these rapidly increase in length until they reach from 2 to 4 inches. Each foliole is acuminate and slightly falcate; its slightly contracted base is fixed somewhat obliquely upon the upper surface of the rachis; the greatest diameter of the leaflet is a little beyond its sessile base. The latter is usually concave, and has either been planted upon an enlargement of the rachis, or has been distended with parenchyma, as is common amongst living species of *Encephalartos*. Each foliole exhibits numerous slightly divergent nervures radiating from the constricted base; of these, about two-thirds are distributed to the upper margin of each leaflet, a few reach the apex, and the remainder disappear along its inferior margin*. In this arrangement

* On this point Brongniart's description of *Zamites* does not agree with the Yorkshire specimens. He says, amongst other characteristics, that they have, "nervures parallèles entre elles *et au bord de la foliole*, et par conséquent convergentes vers le sommet; fines et égales entre elles, *très-rarement bifurquées* lorsque la foliole est élargie

they differ from *Dion edule*, and approach *Encephalartos Caffer*, to the leaflets of which latter species, as well as to those of *Encephalartos lanuginosus*, those of *Zamia Gigas* bear a close resemblance. Both Miquel and Brongniart have pointed out that the fronds exhibit a much closer affinity with the African and East-Indian forms than with the true *Zamiæ* of the American continent. The fronds vary in size, but have often attained a length of 3 feet.

The Peduncle.—Several examples have occurred of a stem or axis covered with large acuminate scales arranged in ascending spiral lines. One of these, in the Scarborough Museum, first satisfied me that they were the squamous peduncles which had supported the singular organisms already referred to, and which I believe to be the organs of fructification. Each peduncle appears to have been from 6 inches to a foot, or even more, in height, sometimes simple, at others branched.

A bifurcated specimen, belonging to Mr. Ripley, is about 2 inches in diameter. After ascending vertically for 7 inches, it dichotomizes, each branch being between 4 and 5 inches in length, and about $1\frac{1}{2}$ inch in diameter immediately above the divergence, but expanding to about 3 inches at its upper extremity. The scales with which it is covered are arranged in a spiral manner, a distribution still better shown in some other fragments which I have seen. Each scale is about 3 inches long, and marked with numerous linear striæ. It is very much dilated at its base, where it clasps the stem, but contracts towards its obtusely acuminate apex. Its upper portion exhibits a slight tendency to the development of a dorsal ridge or keel, but which bears no resemblance to a true midrib. At the extremity of the branch, the spiral arrangement of the scales is less obvious, giving place apparently to a more circular one at the place where the terminal organism has been attached. In this specimen many of the scales have disappeared, owing partly to their accidental fracture, leaving little more than the mass of carbonaceous matter found by their compressed bases; but at the apex, especially of one of the branches and at the point of divergence, they are more perfect.

Organs of Fructification.—The portions of *Zamia Gigas* which, next to the fronds, are most frequently met with are the organisms already referred to, consisting ordinarily of one or more circles of long lanceolate incurved scales, which, when complete, enclose and are surmounted by other appendages. In the examples commonly seen, there is nothing preserved but the whorl of scales, as in Plate LII. figs. 6 & 7. Fig. 6 is the base of a specimen in my own cabinet; the lanceolate scales spring from a central axis, rising first outwards and upwards, then curving inwards at their upper half. I would designate this part of the plant the *involucrum*, regarding the scales as bracts. The figure shows that there are frequently two or more overlapping layers of scales. This specimen is valuable because it is the only one I have seen in which the base of the organism is perfect, indicating the small size of the woody axis of the peduncle. This portion usually appears as represented in figs. 5 & 7, where, owing to their extreme thinness at this part, the bases of the scales have been broken off, revealing a concave

dans sa partie moyenne." I find, on the contrary, that about two-thirds of the nervures disappear at the upper margin of the leaf, and that, by their branching, the leaf contains fully one-third more nervures than start from the sessile base.

annular area of radiating cells. Since the drawing fig. 5 was made, the specimen represented has been accidently reduced to the common form, the central portion having fallen out. It now, like figs. 5 & 7, shows a central cavity, bounded inferiorly by the concave annular area.

The central cavity swells out into a pyriform space once occupied by an expansion of the axis, contracting again towards its upper part, its greatest diameter being at about its lower third. The interior of this cavity is perfectly smooth in the specimen in question. Above the contracted upper extremity it developes into a structure which a second casual fracture revealed after the drawing was made, and to which I shall call attention in connexion with another specimen.

Fig. 7 represents a specimen in which the inferior central portion has become detached. The frequency of this occurrence would have misled me respecting the thickness of the axis at this point, but for the solitary example described; I should have considered that part of the axis to have had, not only a diameter several times greater than has actually been the case, but that it had a convex extremity fitting into the concavity formed by the radiating structures represented in fig. 7. The base of fig. 7 exhibits two concentric circles, the intervening concave area being occupied by numerous small radiating elongated cells* arranged vertically upon the axis; the inner circular margin forms the margin of a large pyriform cavity left by the removal of the axis. I would designate this latter portion of the structure the *pyriform axis*. As in the case of the previous specimen, this cavity contracts superiorly, terminating in a narrow circular aperture; this example, from the Scarborough Museum, also indicates that the outer surface of the pyriform axis has been perfectly smooth.

Fig. 3, a specimen in my own cabinet, carries us a step further, showing the superior constricted part of the pyriform axis expanding into a funnel-shaped appendage, the surface of which has been strongly marked with parallel longitudinal lines. These lines are due, as other specimens demonstrate, to "cells" like those seen at the base of the involucre (fig. 7), but differently arranged, being parallel to the surface of the axis and not vertical. This new arrangement will be demonstrated from other examples.

In nearly all the specimens hitherto discovered, the central axis terminates at the margin of this funnel, which is sharply defined, and at which the diverging grooves end abruptly. That this structure had supported some additional appendage appeared obvious to me; but years of research passed by before I obtained the slightest clue to the missing parts. That it had been deciduous, or at all events very liable to be broken off at this point, was sufficiently obvious, since of the dozens that I examined none exhibited a trace of the terminal organ. A specimen represented in fig. 4 gives additional information respecting the axis. Being in a hard compact stone, the fracture has split the involucrum and its pyriform axis through its centre, showing that the latter was a *solid* and not a *hollow* structure; all its vegetable carbon is preserved *in situ*, in an amorphous condition, intersected with bands of the Scarbroite so commonly found amongst the vegetable remains of these Yorkshire sandstones. This specimen admirably

* I shall use this word to represent these curious cavities, because I can find no better, but without any evidence that the expression is applicable here in its physiological sense.

demonstrates the shape of the pyriform axis, and also the abrupt way in which it terminates superiorly on the detachment of the organ which it sustained.

Fig. 5 represents a specimen closely resembling fig. 7, but giving us additional facts; it exhibits, in the interior of the pyriform peduncle, a cylinder of carbonaceous matter having well-defined boundaries. This cylinder appears to have been separated from the surrounding cortical cells by a narrow interval, which may have been occupied by some different kind of tissue; its inner surface exhibits strongly marked longitudinal parallel grooves, which extend upwards into the constricted part of the axis. This cylinder bears the aspect of a woody zone, of which the longitudinal ridges represent vascular bundles; but if so, the vessels have been much more densely packed, as well as more regularly parallel to each other, than in recent Cycads.

This specimen, belonging to Mr. Ripley, also affords indications of the extension of the pyriform axis beyond the usually terminal funnel, and shows that the latter became suddenly contracted by a curious inflexion of the tissues composing it, and further indicates that the centre of the lenticular disk thus formed has been extended upwards into a central prolongation. Two invaluable specimens in my own cabinet confirm and further illustrate this part of the structure. One of these contains the pyriform axis detached from the involucrum; on splitting the specimen, in order to trace its upward prolongation, I obtained the conclusive results indicated (double the natural size) in figs. 7, 8, and 9 (Plate LIII.), demonstrating the actual termination of the axis. The last two figures represent the two halves of the specimen, showing the upper extremity of the axis: the pyriform dilatation does not appear in the drawings, being on the reverse side of the fragment indicated by fig. 8; but fig. 9 exhibits the appearance this specimen would have presented had the fracture happened to pass through the central plane of the specimen. In fig. 8, as just stated, the pyriform axis is imbedded in the stone. It differs from all the other examples I have seen in having the interior surface of the hollow cast marked by numerous irregular longitudinal rugæ. As the specimen has no traces of the involucrum attached to it, and as it is the only one in which I have found the surface of this part of the axis otherwise than smooth, I think we may attribute these rugæ to the partial shrivelling of the organism prior to its fossilization. At the base of fig. 10 we see a small portion of the grooved funnel, the striated surface of which only extends about half the distance between its outer margin and the constricted part of the pyriform axis below. From this margin the axis rapidly contracts superiorly, in the way represented in fig. 7, demonstrating that the funnel-shaped structure was the inferior part of a disk, to which I would apply the name of the lenticular disk. Inferiorly, the surface of this disk has been concave, and convex on its upper surface, the central portion of the latter being further prolonged into a pyramidal structure about an inch in length. This structure may be designated the pyramidal axis; its surface is indented with numerous longitudinal grooves and striæ, very similar to those on the inferior surface of the lenticular disk, but not quite so strongly defined. In fig. 10, some of these longitudinal grooves are more deeply indented than others, and this difference is not seen on the opposite side of the pyramid represented by fig. 8. Near its upper extremity the pyramidal axis again expands into a cup-shaped enlargement about one-

fourth of an inch in diameter (fig. 7), and from the centre of this there arises a small terminal mammillary projection, rather more than the eighth of an inch in height and breadth; to this cup and its terminal mamilla I would give the provisional name of the *corona*.

Two specimens in my cabinet exhibit the lenticular disk, with its pyramidal axis and corona, in a much less completely developed state. One of these is in the example fig. 5. A vertical section is shown in fig. 9. In this state the corona is well developed; the mamilla is more acute than in fig. 6; but the pyramidal axis is almost wholly wanting, the corona being nearly sessile upon the depressed centre of the lenticular disk. This obviously appears to be a less developed condition of the organ than the other specimen (figs. 6–8) indicates; and the general aspect of the involucrum (fig. 7) suggests the same idea, it being much less globular than is the case with fig. 6. These younger specimens afford almost absolute proof that the corona is the terminal portion of the central axis. I have now seen four of these rare examples, and they all bear the strongest marks of terminal completeness. It may be worthy of note that the specimen (figs. 10, 11, 12), the only one I have seen in which the pyramidal axis is fully developed, is the only one also in which the surface of the pyriform axis is shrivelled and corrugated, instead of smooth, as if the organ had fulfilled its mission and was drying up.

Having thus ascertained the form of the axis, we may now turn to some anomalous features in its structure. Attention has been drawn to the ring of radiating cells at the base. These are arranged like the cells of the honeycomb, each one being in turn the centre of a surrounding group of six others (fig. 10); but they are often so compressed that it is only under favourable conditions that this arrangement can be determined; nevertheless it is an unquestionable fact. These cells appear to have formed a cortical layer, arranged vertically upon and extending over the entire surface of the pyramidal axis, having a probable thickness of from half to three-quarters of an inch at the lower and central portions, and becoming thinner on approaching the constricted part of the axis, and most probably disappearing before reaching the funnel-shaped base of the lenticular disk. I infer that it was coextensive with that part of the pyriform axis of which the cast in the specimen, fig. 7, exhibits an uninterruptedly smooth surface. That it invested a great part of that surface, was shown by a specimen formerly in the possession of Mr. James Yates, and now, I believe, in the collection of the Jardin des Plantes at Paris, as also in one in Mr. Ripley's cabinet; and as all the specimens demonstrate a change in the tissues forming the surface of the axis, where the radiating grooves appear on the funnel-shaped base of the lenticular disk, I conclude that at this point this layer of cells thinned out, so far as the vertical series was concerned. Each cell was in close contact, at its inner extremity (fig. 11), with the smooth surface of the pyramidal axis. Externally it seems to have presented a rounded contour, giving a crenulated outline to the vertical section of this tissue.

This structure is invariably seen at the base of each involucrum, as represented in figs. 3 & 6 (Plate LII.). I conclude that these cortical cells formed a layer that was deciduous, being very easily detached from the smooth surface of the peduncle, and that the ring which is so invariably preserved round the base of the involucrum is only the

lowermost margin of the layer retained *in situ* because wedged in that position, externally by the bases of the bracts of the involucrum, and internally by the substance of the pyriform peduncle. The smoothness of the surface of the peduncle, demonstrated by several examples, clearly indicates that the connexion between it and the investing cells has been very slight; the detachment of the latter may have resulted either from maceration in water readily severing this connexion, or from the tissue having been truly deciduous, and destined to be thrown off like many recent antheriferous structures.

Attention has been directed to the radiating striæ marking the outer surface of the funnel-shaped base of the lenticular disk (Plate LII. fig. 5): I have several specimens demonstrating that at least the exterior of this part of the axis has been composed of elongated cells similar *in appearance* to those of the cortical layer; but they appear to have formed a permanent part of the axis, being almost invariably found *in situ* when the carbonaceous matter is preserved. Whether they occupied the whole diameter of the peduncle, or only formed an external layer, I cannot determine*. Instead of being arranged vertically to the surface of the axis, they are disposed longitudinally and in symmetrical parallel lines, following the curves of the exterior of the axis; their terminations are seen on the upper surface of the lenticular disk, especially at its peripheral portion (fig. 6). The exact relation of these cells to those of the outer layer is uncertain, but there is always a remarkable break in the continuity of the tissues here, showing some important change in their arrangement. In the undeveloped examples (Plate LIII. fig. 9) a thin series of the most superficial of these cells appear on the surface of the lenticular disk, converging towards the base of the pyramidal axis, which they then ascend, and are continued in the same manner to the extremity of the central mammillary apex of the corona. It thus appears that at least the surface of the axis above the narrow base of the lenticular disk has been composed of a series of elongated cells or tubes, arranged longitudinally and following the curves of the surface, and that a number of them terminated abruptly at or immediately beneath the upper surface of the lenticular disk. As seen in fig. 7, many of the superficial grooves caused by these tissues are more strongly marked than the rest, recurring at regular intervals. The undeveloped specimens indicate a similar external contour.

Along with the specimens described some others are found having a very different aspect, but apparently belonging to the same plant. Fig. 2, Plate LII., represents one of them in the Scarborough Museum, of the natural size; it is a cast showing the inferior surface of the organism. It is a funnel-shaped body; the hollow interior is about an inch in depth, and rather more than half an inch wide at its fundus, enlarging to about an inch at its upper part, where it suddenly expands into a broad disk, having a diameter of nearly 4 inches, exclusive of a circle of radiating appendages. The latter exhibits a slight tendency to be recurved downwards. The entire surface is marked by numerous irregular radiating striæ, and also by several grooves and corrugations, which are strongest in the tubular portion of the specimen. Round its peripheral margin are the remains of a number of radiating appendages, each being about an inch in length,

* Since the above was written, I have ascertained that they form a *well-defined* external cylinder about $\frac{1}{8}$ inch in thickness.

and from $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter at the base, tapering to a point, whilst curving outwards and upwards.

Fig. 1, Plate LII., represents another specimen which exhibits additional points of the greatest interest. In tab. 1. fig. 2 of Young and Bird's 'Geological Survey,' there is given a representation of a fossil from the collection of the Whitby Philosophical Society, which the Council has permitted me to examine, along with its reverse, also in their possession. The specimen is well preserved in the centre of a block of compact sandstone; but, as is so often the case with these fossils, especially where the vegetable structure has been of some thickness, the friable carbonaceous matter has fallen away on the fracture of the matrix, exposing the superior and inferior aspects of the organism. The lower surface is figured by Young and Bird; generally it resembles the one described (fig. 2), but is somewhat smaller, the disk exclusive of the rays being only about 2 inches in diameter. The central cavity is at the same time wider and shallower, being more saucer-like. Its diameter, superiorly, is about $1\frac{1}{4}$ inch, whilst its depth is barely $\frac{3}{8}$ inch. At its fundus there is an irregular but well-defined circle, $\frac{3}{8}$ inch wide, which I believe marks the thickness of the peduncle which supported it; and from the margin of this small circular space, as from the fundus of fig. 2, numerous strongly marked rugæ radiate towards the margin of the depressed cavity, and become less definite as they ascend towards its brim, where they are almost wholly lost. These of course represent corresponding corrugations on the *exterior* of the organism. The peripheral radii are truncated at their extremities, as represented by Young and Bird; but this is accidental, arising from their apices being imbedded in the matrix. The Council allowed me to employ my chisel as stated above, and the result was the display of the magnificent specimen represented by fig. 1, being the cast of the *superior* surface of the organism.

Its centre is occupied by a large projecting truncated boss, on the upper surface of which is a slight depression, indicating a corresponding elevation on the surface. Though a few faintly developed folds are seen running down the sides of this projecting boss, there is nothing like the numerous striæ seen in fig. 2. There are, however, some circular markings of another kind, to which I shall have to refer by-and-by. At the base of the boss the organism spreads out into a disk, the margin of which supports fifteen pointed rays; each of these is about an inch in length and $\frac{3}{8}$ inch wide; they are somewhat constricted at their origin, but bulge out a little before reaching their centre, and then gradually taper off to their outer apex. Their direction is first outwards and then upwards, the whole structure having the appearance of a starfish in which the extremities of the rays have been curled up. Different portions of the specimen exhibit the form of both the upper and lower surfaces of these rays, from the carbon of some of them being retained *in situ*. The inferior surface has originally been a little concave from side to side, the margins curling slightly downwards. The superior surface, on the other hand, has a strong central longitudinal projection (figs. 3 & 4, Plate LIII.), extending from the apex to about the middle of the ray, its position being shown in the cast by a corresponding depression. On each side of this ridge, the surface of the ray has been concave. Where the large *central* depression, *d*, terminates *in the fossil cast*,

every ray exhibits two small parallel oval protuberances, each being about $\frac{1}{4}$ inch long, and about $\frac{1}{8}$ inch wide. In the fossil itself these mark the position of two depressions (Plate LIII. fig. 3) in each ray, separated from each other by a slight prolongation of the central ridge. The further prolongation of the mesial line can be detected in the direction of the centre of the entire organism, *f*, and on either side of it, especially when it traverses the disk, are traces of a row of small circular pits (Plate LII. fig. 1), each being about $\frac{1}{16}$ inch in diameter. The depth of these little pits is very slight, and their outline often wants definition; but they are sometimes so distinct as to establish the fact that they formed a characteristic feature of the organism. I propose to call this structure by the provisional name of the carpellary disk.

Thus far I have confined myself to describing the specimens, without attempting to draw from them any inferences. These have shown that we have an arborescent stem marked with the rhomboidal scars of fallen leaves, as in *Cycadeæ*. We have leaves, the Cycadean affinities of which no one disputes, springing from the summit of the stem; then we have a peduncle (Plate LIII. fig. 13) clothed with scales, identical with the *squamæ foliares* of Link, the uppermost ones having been more elongated than the rest. This peduncle sustained the involucrum, composed of verticils of similar but much longer scales or bracts, within which there arose a pyriform axis with a smooth exterior, supporting a superficial layer of oblong cells arranged vertically on its outer surface. Superiorly the axis contracted, and again expanding to form the lenticular disk, then shot up into the pyramidal axis, and terminated in the corona.

We find associated with the above fossils the radiating organism provisionally designated the carpellary disk, and of which a restored figure is given in Plate LIII. fig. 2, a structure having many indications that it was the female reproductive organ of a gymnospermous plant. All the remarkable objects enumerated occur in the same blocks of sandstone, unassociated with any other plants to which they can be referred with any show of probability. The inference that they are parts of one plant, though incapable of proof, is forcibly suggested. Adopting this interpretation, I will venture on a few hypothetical conclusions, such as may guide future observers either to their confirmation or to a correction of my errors. At all events such suggestions will raise definite points for further investigation.

Remembering the diœcious character of living Cycads, it is probable that the fossil forms were also diœcious. The two different organisms, restored in figs. 2 & 13 (Plate LIII.), may be the male and female reproductive organs of *Zamia Gigas*. Remembering further the frequency with which the male organs are deciduous amongst living plants, we note with interest the significant probability that the pyriform axis of fig. 6 was invested by a deciduous antheriferous tissue. The examples from which the restored diagram (fig. 2) was constructed, afford more positive evidence that they were female organs. They recall the bracts of the female cones of living Cycads, with their pairs of ovules symmetrically disposed, and make it more than probable that the two oblong depressions on the surface of fig. 3 supported ovules, as indicated in figs. 2 & 4, while the two parallel centripetal rows of small depressions (fig. 2) may mark the position of corresponding pairs of *abortive* ovules.

If this be a correct interpretation of the organism, it has been a verticil of altered leaves which have coalesced below into a funnel-shaped disk, but yet show in the free peripheral rays the number of leaves entering into its composition. This interpretation has been strengthened by the discovery of a small seed represented in figs. 14 & 15 (Plate LIII.). I found this seed imbedded among the bracts of a scaly peduncle when breaking it. It exactly corresponds in size to the depressions in fig. 3, where it was, I believe, borne. Its upper extremity is rounded (fig. 15), somewhat depressed, and nearly smooth; its opposite end is more prominent and rougher. When originally found it was covered by a thin film of carbonaceous matter, and its matrix still exhibits a faint brownish stain surrounding the nut. Its surface is very slightly marked with longitudinal lines resembling those of the putamen of *Encephalartos Caffer*.

No example has yet been discovered in which the radiating carpellary disk has retained its connexion with the peduncle. Its vascular tissues seem to be more developed on its inferior than on its superior surface. I infer this from impressions of the former (Plate LII. fig. 2) being always strongly grooved longitudinally, while those of the latter, which I have seen, are smooth. The upper part had probably a thick layer of parenchyma. With such reasons for supposing that this has been the representative of the female cone, we attain to a negative probability that the involucrum and its appendages have been the male organ. That the cells on the pyriform axis did not contain ovules, as some have deemed probable, I am convinced. We constantly find them in such excellent preservation, that some traces of ovules would have been retained had they ever existed. Besides their very small diameter precludes the idea. That the expanded lenticular disk performed some important function is most probable. Its upper surface may have been also antheriferous, and this possibility is further sustained by the circumstance that this part of the structure also appears to have been deciduous. Of all the numerous involucra which I have seen, I have only met with three or four in which these uppermost parts of the axis were not wanting. Fig. 4 accurately indicates the way in which this organ has usually been truncated prior to its being imbedded in the matrix. Thus, though the cells in the funnel-shaped part of the peduncle remain, their upper extremities, with whatever they sustained, were almost invariably detached.

Assuming the specimens of stems described to belong to *Zamia Gigas*, the plant must have had the habit of *Cycas circinalis*, and I have accordingly so restored it in Plate LIII. The dichotomous scaly peduncle is adopted on the authority of a specimen in the Scarborough Museum; this may, however, be exceptional, just as a double cone is in recent Cycads.

I must, in conclusion, express my gratitude to the several individuals who have aided me in this inquiry. To my friend Mr. James Yates, of Highgate, I owe many thanks. for the sight of drawings and specimens which he has ever been willing to communicate to others. The kind assistance of the Council of the Philosophical Society of Whitby has already been acknowledged. The Scarborough Philosophical Society also allowed me the same liberal use of specimens from their fine local collection. The nearness of our relationship would not justify my overlooking the diligence with which my veteran father has pursued the search for these Cycadean relics during fifty years of field-work

on the Yorkshire coast, whilst the invaluable and suggestive assistance of M. Adolphe Brongniart has always been available whenever specimens were submitted to his inspection. Would that I could personally thank three other geologists, whose cabinets were freely thrown open to me; but Dr. Murray and Mr. Bean, of Scarborough, and Mr. Ripley, of Whitby, have passed beyond the reach of earthly thanks since most of the preceding pages were written.

EXPLANATION OF THE PLATES.

Plate LII.

Fig. 1. Cast of the superior surface of the "carpellary disk."
Fig. 2. Cast of the inferior surface of ditto.
Fig. 3. Inferior aspect of an involucrum, showing the cylinder of vascular tissue within the pyriform axis.
Fig. 4. Longitudinal section of an involucrum, with the pyriform axis and the inferior half of the lenticular disk.
Fig. 5. Upper portion of an involucrum, with the impression of the inferior surface of the lenticular disk.
Fig. 6. Basal aspect of a matured involucrum, in which the central portion has been broken away, revealing the interior of the pyriform axis.
Fig. 7. Basal aspect of a young involucrum.

Plate LIII.

Fig. 1. Restoration of the male plant of *Zamia Gigas*.
Fig. 2. Restoration of half of the carpellary disk, showing the vascular exterior, the superficial parenchyma, the ovules *in situ*, and the position of the supposed abortive ovules.
Fig. 3. One of the rays of fig. 1, Plate LII.; double natural size.
Fig. 4. Ditto, with seeds in position; restored.
Fig. 5. Impression of a portion of the exterior of the stem.
Fig. 6. Upper part of the pyriform axis with the pyramidal axis and corona.
Fig. 7. The pyramidal axis and corona.
Fig. 8. Ditto, ditto.
Fig. 9. Section of immature lenticular disk and corona.
Fig. 10. Transverse section of the cells investing the pyriform axis.
Fig. 11. Longitudinal section of ditto.
Fig. 12. Restoration of the involucrum.
Fig. 13. Restored section of ditto.
Fig. 14. Seed; nat. size.
Fig. 15. Seed; enlarged.

Note.—Since writing the above Memoir, Mr. Leckenby's cabinet has afforded me proofs that *Pterophyllum pecten* was a *Williamsonia*. He has both forms of fructification. A specimen of *P. pectinoides* shows that this species should also be referred here. I have ascertained that the external layer of elongated cells of the funnel-shaped base of the lenticular disk was about $\frac{1}{8}$ inch in thickness, and that its inner surface was as sharply defined as its outer one.

Fig 1

Fig 2

Fig. 3

Fig. 4

Fig 5

Fig. 6.

Fig. 7

W. G. Smith F.L.S. lith: W. C. Williamson, del:

Williamsonia Gigas. (Zamia Gigas.)
all nat size

Fig. 2. nat size.

Fig. 3. twice nat. size

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 10.

Fig. 12.

Fig. 11.

Fig. 9

Fig. 13.

Fig. 14.

Fig. 15.

W. G. Smith F. L. S. lith. W. C. Williamson, del.

Williamsonia Gigas. (Zamia Gigas.)

XVIII. *On Fossil Cycadean Stems from the Secondary Rocks of Britain.*

By Wm. Carruthers, *Esq.*, *F.L.S.*, *F.G.S.*

(Plates LIV.–LXIII.)[1]

Read June 18th, 1868.

The organisms found in Palæozoic rocks, referred by some authors to *Cycadeæ*, either are so fragmentary that it is impossible to determine, with any approach to certainty, their systematic position, or they belong to other orders of plants. The leaves that have received specific names are imperfect fragments. The detached fruits present no characters justifying their reference to *Cycadeæ*. The stems from the Coal-measures, figured and described by Presl[2] under the names *Cycadites columnaris*, *C. involutus*, and *Zamites Cordai*, are certainly arborescent cryptogams belonging to the same group as *Lepidodendron*, as Brongniart[3] and Miquel[4] have already shown. This is the position also of Guillard's *Cycadium cyprinopholis*[5], from the Coal-measures of Rive de Gier, in the centre of France. Some uncertainty may be entertained regarding the Permian stems found in Russia, and described by Eichwald[6]; and yet a careful examination of the materials at my command has satisfied me that their claims to be considered *Cycadeæ* cannot stand. Of the seven species, five are described from the impressions of the outer surface of the stems preserved on the fractured surface of the rock, and only in the other two are there materials sufficient to show any traces of the form and structure of the stem. In these two (*Tessellaria antiqua* and *Diplodendron hastatum*) there is a remarkable approach, in the arrangement of the parts, to *Cycadeæ*. It should be remembered, however, that the Lepidodendroid fossils which abound in the later Palæozoic strata, and four of which are described by Eichwald from the beds in which his supposed Cycads occur, had the different parts entering into the structure of the stem arranged upon the same plan as in *Cycadeæ*. In both, the vascular cylinder enclosed a ventral axis of more perishable tissues, and was surrounded by a cortical cellular layer, through which the vascular bundles passed to the leaves. In some genera in both groups the leaves separated at, or near to, the cortical layer, as in *Cycas* and *Lepidodendron*; while in others a portion of the petiole was left permanently attached to the stem, as in *Encephalartos* and *Lepidophloios*. But notwithstanding this remarkable correspondence in the arrangement of the parts, their minute

[1] These plates have been drawn directly on the stone, with singular truthfulness and power, by Mr. W. G. Smith, F.L.S. The expense was defrayed by a grant from the fund for the promotion of science, placed annually by Parliament at the disposal of the President and Council of the Royal Society, obtained for me by the kind offices of Dr. Hooker. Many of the sections have been prepared by the help of the fund voted by the British Association for investigating the Fossil Flora of Britain. The others had been prepared for Robert Brown and Dr. Hooker.

[2] Sternberg, Vers. Fl. d. Vorw. vii. & viii. Heft, pp. 194 & 196.

[3] Tabl. Gen. Vég. Foss. p. 59.

[4] Tijdschr. Nat. Weten. v. Ned. Inst. vol. iv. (1851) p. 205.

[5] Ann. des Sc. Phys. & Nat. d'Agricult. de Lyons, vol. ii. p. 123.

[6] Lethæa Rossica, vol. i. pp. 215–227.

structure determines their systematic position as certainly as the seeds of the one and the spores of the other. In the *Cycadeæ* the vascular cylinder is composed of disk-bearing tissue, everywhere traversed by medullary rays; it invests a true cellular medulla, and is surrounded by a cellular cortical layer; while in *Lepidodendron* and its allies the vascular cylinder consists of scalariform tissue, without true medullary rays; it encloses an axis of large irregular scalariform tissue, and is surrounded by a somewhat complicated outer layer, composed, in the inner portion, of parenchyma, and in the outer, of prosenchyma[1]. Unfortunately the minute structure is not preserved in Eichwald's stems. But there appear to me to be, nevertheless, in *Tessellaria antiqua* and *Diplodendron hastatum* the means of determining with some certainty to which of the groups they belong. I refer to the proportion which the vascular cylinder bears to the diameter of the stem. In the palæozoic cryptogams the cellular cortical layer is enormously developed, and the vascular cylinder is correspondingly reduced, while in the *Cycadeæ* the vascular cylinder is larger and nearer to the circumference of the stem. The two fossils figured by Eichwald agree in these particulars with *Lepidodendron*; and I accordingly prefer to place them in that genus, as was originally done by Kutorga. Göppert[2] has removed one of these stems (*Diplodendron hastatum*) from *Cycadeæ* and placed it among the *Lepidodendreæ*; but he retains *T. antiqua* among the *Cycadeæ*, without, however, giving any reason for separating two stems which agree in all points of structure in which they can be compared. I have been greatly assisted in the critical examination of these stems by the casts of them presented to the British Museum by Sir R. I. Murchison. The materials for estimating the affinities of the other five species described by Eichwald are less satisfactory. There are no characters by which *Zamites microlepis* and *Tessellaria squamosa*, retained by Göppert in *Cycadeæ*, can be separated from *Lepidodendron*. *T. biarmica*, considered by Göppert to be a fern-stem, is a "decorticated" specimen of a plant of the same genus; and *Zamites strigatus* and *Z. densifolius*, referred by Göppert to *Cycadeæ*, are too imperfect and obscure to warrant even a guess as to their affinities.

The structure of *Medullosa*, Cotta[3], and *Colpoxylon*, Brongn.[4], referred by Göppert, Miquel, and Unger to *Cycadeæ*, differs so essentially from any known stem of that order, that I would even go further than Brongniart, who considers their Cycadean claims to be very doubtful, and say that, as far as the evidence supplied by the stems goes, their affinities are much more with the vascular cryptogams than with any tribe of phanerogams.

No satisfactory evidence, then, exists, as far as I am aware, of the occurrence of *Cycadeæ* in any Palæozoic formation. In strata of Secondary age their remains are both abundant and characteristic. Stems, leaves, and fruit are so perfectly preserved that their true nature can be determined with the utmost precision. They are, on the other hand, remarkably absent from beds of Tertiary age. The stem from the Paris basin, referred by Presl to this order, under the name *Zamites Brongniartii*[5], is, as Brongniart originally

[1] Brongniart, Ann. Sc. Nat. ser. i. vol. xvi. p. 389. Miquel, Stamm d. Cycas, Linnæa, 1844, p. 125. Carruthers, "On the Structure of the Stems of the Arborescent Lycopodiaceæ of the Coal-measures." Monthly Microscop. Journ. vol. i. p. 177.

[2] Fossile Flora der Perm. Form. p. 132.

[3] Die Dendrolithen in Beziehung auf ihren innern Bau (1850), p. 60.

[4] Tabl. Gen. Vég. Foss. p. 60.

[5] Sternberg, Flora d. Vorwelt, ii. p. 196.

described it, an Endogen. The only other supposed indication of Tertiary *Cycadeæ* is the fragment of a leaf (*Zamites arcticus*) described by Göppert, from the Miocene beds at Kook, in Greenland[1]. This specimen is not only imperfect, but it is so anomalous that even those who believe it to be Cycadean can find no analogous form either recent or fossil. It cannot be supposed that *Cycadeæ* were absent from the vegetation of the Tertiary period[2]; their non-discovery hitherto must be taken as another instance of the imperfection of the record of extinct life with which students have to deal.

I do not propose in this memoir to refer to the species of *Cycadeæ* founded on foliage only. The detached fruits with which I am acquainted I have described in a paper on the Gymnospermatous Fruits of the Secondary rocks[3]. I shall confine myself to the various forms of stems which have been found in Britain, including also, where materials exist, the fruits and foliage associated with them, and examining the evidence their remains afford as to the relations they bear to the recent members of the Order.

Bibliography.—In 1822 Mantell published an account of some vegetable fossils he had obtained from the sandstones of Tilgate Forest[4], the affinities of which he was unable to determine. They were fragments of stems which were "composed of a cylindrical imbricated axis, marked with interrupted longitudinal striæ, and a cortical layer covered externally with rhomboidal markings." He supposed that they might be ferns or palms, or, more probably, *Euphorbiaceæ*. Some time afterwards he sought the opinion of the members of the Geological Society of London on these anomalous remains, and Messrs. Stokes and Webb were appointed by the Council to describe and publish them in their Transactions. In their report[5] they recognized the external resemblance the fossils bore to the stems of *Zamia* and *Cycas*, but they held that they differed "from these or any other known family in enclosing an internal body marked on its surface, and that very differently so from the external covering." They, however, placed the fossils in *Clathraria*, a genus established by Brongniart[6] for a group of stems previously included in Sternberg's genus *Lepidodendron*.

Presl, in 1825, in his synopsis of fossil plants, published in Count Sternberg's great work[7], separated the Tilgate fossils from *Clathraria* and referred them to *Cycadeæ*, establishing for them the genus *Bucklandia*. In a later systematic account of fossil plants in the same work (1835) this genus is altogether omitted, and no notice is taken of the fossil for which it was established.

Brongniart, in 1828[8], examined at some length the affinities of these singular stems; and believing that they agreed in the arrangement of their parts with the trunks of *Xanthorrhœa*, he referred them to *Liliaceæ*. This opinion was very generally adopted[9], but

[1] N. Jahrb. f. Mineralogie, 1866, p. 113.

[2] Coemans, in his "Flore Fossile du Terr. Crét. du Hainaut" (Mém. de l'Acad. Roy. de Belg. vol. xxxvi. p. 5), says that some isolated Cycads are found in Tertiary strata; but he does not refer to any instances.

[3] Seemann's Journal of Botany, 1867, p. 1.

[4] The Fossils of the South Downs, pp. 42, 43.

[5] Trans. Geol. Soc. ser. 2, vol. i. (1824) p. 422.

[6] Mém. du Mus. vol. viii. (1829) p. 209.

[7] Flora der Vorwelt: Tentamen, p. xxxiii.

[8] Prodrome d'une Histoire des Végétaux Fossiles, p. 128.

[9] Lindley, Introduction to Fossil Flora (1832), p. xlii; Endlicher, Gen. Plant. (1836), p. 257; Unger, Gen. et Spec. Plant. Foss. (1850), p. 314; Ettingshausen, Abhandl. d. K. K. geol. Reichs. vol. i. (1852) Abth. 3, Nr. 2, p. 8.

was given up by Brongniart in 1849[1], when he referred them to *Cycadeæ*, but with some doubt, as he considered that their true affinities must remain obscure until their internal structure or their foliage was known. Brongniart did, however, in his 'Prodrome' (1828), establish a genus of fossil Cycads, founded upon stems, to which he gave the name *Mantellia*. Two species were described—the one from England, the other from France. In the same year Buckland communicated to the Geological Society of London his important memoir "On the *Cycadeoideæ*, a family of Fossil Plants,"[2] in which he described two species from the Isle of Portland, one of them being the same as the English species of Brongniart. The Cycadean affinities of these stems were clearly established by both authors, and were further elucidated by Buckland in his 'Bridgewater Treatise'[3]. Another British species was added to the genus by Lindley and Hutton[4], a fourth by Robert Brown[5], and a fifth more recently by myself[6].

A fossil figured by Sternberg[7], and regarded by him as a coniferous cone, by Presl[8] and Buckland[9] as probably Cycadean, and by Brongniart, at first[10], and Lindley[11] as a Liliaceous stem, was at last referred by Brongniart, in 1849, to its true position among the stems of Cycads[12].

The only other fossil found in Britain which has been considered the stem of a Cycad, is a small fragment figured and described by Corda[13]. Although he believes that the specimen was obtained from England, he does not know the locality in which it was originally found.

Several forms of Cycadean stems have been recorded from Secondary rocks on the Continent. Brongniart, as I have already stated, in his 'Prodrome' refers a cylindrical stem from Lunéville to his genus *Mantellia*. In 1849, Pomel, in a Memoir on the Fossil Flora of the Jurassic rocks of France[14], revised the published species, added a new genus, *Crossozamia*, with three species, based partly on the characters of the stem, and described two new species, which he referred, the one to *Bucklandia*, and the other to *Mantellia* (*Echinostipes*, Pom.).

Göppert, in 1844[15], described two Cycadean stems from Silesia, for which he established the genus *Raumeria*. In a subsequent memoir[16], he described more fully and illustrated the structure of these fragmentary stems. They are cylindrical and marked with the bases of the leaves, which are separated by quincuncially arranged rhomboidal cicatrices of "scales or stipules." This is unlike any thing in recent *Cycadeæ*, but reminded Göppert of the arrangement of the scars on some fern-stems, and consequently induced him to establish for them a distinct tribe of *Cycadeæ*, with the designation *Filicoideæ*.

[1] Tableaux des Genres de Végétaux Fossiles, p. 91.
[2] Trans. Geol. Soc. ser. 2, vol. ii. (1829) p. 395.
[3] Geology and Mineralogy (1836), p. 490.
[4] The Fossil Flora of Great Britain, vol. ii. plate 143.
[5] Proceedings of the Linnean Society, No. xlvi. (1851), p. 130.
[6] Geological Magazine, vol. iv. (1867) p. 199.
[7] Flora der Vorwelt, fasc. iii. p. 39.
[8] Tentamen Floræ Primord. (Flora der Vorwelt) (1825), p. 33.
[9] Trans. Geol. Soc. ser. 2, vol. ii. (1829) p. 400.
[10] Prodr. d'une Hist. des Vég. Foss. 1828, p. 128.
[11] Introd. to Fossil Flora (1833), p. xlii.
[12] Tabl. des Genres de Végétaux Fossiles, p. 91.
[13] Beiträge zur Flora der Vorwelt (1845), p. 38, tab. xvii.
[14] Amtlicher Bericht über d. 25. Vers. d. Gesellsch. deutsch. Nat. und Aerzte in Aachen, 1847 (1849), p. 340.
[15] Wimmer, Flora von Schlesien (1844), vol. ii. p. 217.
[16] Denkschrift der Schlesischen Gesellsch. für vaterl. Kultur (1853), p. 259.

In 1847, F. Braun recorded the discovery of five species of Cycadean stems from the Keuper of Culmbach, in Bavaria, but did not publish any description of them[1].

M. Coemans found the stem of a Cycad in the remarkable gymnospermatous flora of Hainault, of Cretaceous age, which he figured and described in 1866[2].

In India, stems of *Cycadeæ* have been found in the Rajmahal series, Rajmahal Hills, Bengal, several of which have been figured by Oldham and Morris[3]. Dana[4] records the discovery by P. T. Tyson of large stumps of Cycads, in beds believed to be Upper Jurassic, near Baltimore, Maryland. One of the specimens is 12 inches in diameter and 15 inches high. Emmons has found stems in the Triassic rocks of North Carolina[5].

Classified enumerations of the species have been given in the scientific works and memoirs of S. Woodward[6], Morris[7], Presl[8], Göppert[9], Miquel[10], and Unger[11].

Synopsis Generum Cycadacearum Fossilium e Truncis notorum.

Tribus I. Cycadeæ, Alph. DC. Prodr. vol. xvi. Sect. ii. p. 525.

Spadices masculi in strobilos dispositi, cuneati, subtus pollinigeri; feminei magni foliacei, marginibus utrinque ovula plura erecta gerentes.

Gen. 1. Bucklandia, Presl. Truncus cylindricus, coarctatus, elongatus, plerumque indivisus, cicatricibus spadicum, squamarum petiolorumque deciduorum cicatrisato-areolatus.

Sp. 1. *B. anomala,* Presl; cicatricibus magnis obliquis subrhomboideis angulis lateralibus truncatis.
Form. Wealden. *Loc.* Cuckfield, Sussex.

Sp. 2. *B. Mantellii,* sp. nov.; cicatricibus horizontalibus rhomboideis, angulis lateralibus acutis.
Form. Wealden. *Loc.* Cuckfield, Sussex.

Sp. 3. *B. squamosa,* Brongn.; cicatricibus ignotis, squamis triangulatis.
Form. Lower Oolite. *Loc.* Stonesfield.

Sp. 4. *B. Milleriana,* sp. nov.; cicatricibus parvis obliquis subrhomboideis, angulis lateralibus subtruncatis.
Form. Middle Oolite. *Loc.* Brora, Sutherlandshire.

Tribus II. Zamieæ.

Spadices in strobilos dispositi, masculi imbricato-cuneati subtus pollinigeri, vel peltati sub pelta pollinigeri; feminei stipitati, peltati v. imbricati, ovulis 2 supra basin spadicis utroque latere symmetrice dispositis reflexis.

Gen. 2. Yatesia, gen. nov. Truncus cylindricus indivisus vel dichotome ramosus, squamis et petiolorum basibus persistentibus obtectus.

[1] Regensburg Flora (1847), pp. 84, 85.
[2] Mémoires de l'Acad. Roy. de Belgique, vol. xxxvi. Mém. 3 (1867).
[3] The Fossil Flora of the Rajmahal Hills (1862), pl. xxxiv.
[4] Manual of Geology (1863), p. 472.
[5] American Geol. pt. vi. (1857) p. 123.
[6] A Synoptical Table of British Organic Remains (1830), p. 3.
[7] Ann. & Mag. of Nat. Hist. (1841), vol. vii. p. 110; Catalogue of British Fossils, pp. 1–25.
[8] Sternberg, Flora der Vorwelt (1838), pp. 194–196.
[9] Auszug der Schlesischen Gesellsch. f. vaterl. Kultur (1844), p. 32.
[10] Monographia Cycadearum (1842), pp. 34, 35, 60, 61; Tijdschr. der eerste Kl. v. K. Ned. Inst. vol. iv. (1851) p. 205; Prodromus Syst. Cycad. (1861), pp. 29–34.
[11] Genera et Species Plantarum Fossilium (1850), pp. 279–310.

Sp. 1. *Y. Morisii*, Carr.; squamis et basibus petiolorum horizontalibus, non imbricatis, apice truncatis, tumidis.

Form. Lower Cretaceous. *Loc.* Potton, Bedfordshire.

Sp. 2. *Y. gracilis*, sp. nov.; trunco tenuissimo, squamis et basibus petiolorum adscendentibus imbricatis, cicatricibus rhomboideis.

Form. Lias. *Loc.* Lyme Regis, Dorsetshire.

Sp. 3. *Y. crassa*, sp. nov.; trunco humili, squamis et basibus petiolorum patentibus vix imbricatis, crassis, transverse subovoideis.

Form. Middle Oolite. *Loc.* Brora, Sutherlandshire.

Sp. 4. *Y. Joassiana*, sp. nov.; trunco erecto, basibus petiolorum brevibus vix imbricatis, squamis ad basin strobilorum confertis.

Form. Middle Oolite. *Loc.* Brora, Sutherlandshire.

Gen. 3. Fittonia, gen. nov. Truncus obovatus humilis, squamis et petiolorum basibus magnis geniculatis persistentibus tectus.

Sp. 1. *F. squamata*, sp. nov.; squamis oblongis apice obtuse rotundatis, basibus petiolorum infra articulationem constrictis.

Form. Upper Cretaceous. *Loc.* Bonchurch, Isle of Wight.

Gen. 4. Crossozamia, Pomel. Truncus oblongo-ellipsoideus, petiolorum basibus brevibus subimbricatis tectus; folia pinnata, petiolata, pinnis basi contractis lineari-lanceolatis oblongisve; spadices feminei in strobilos dispositi, imbricati, adpressi, lanceolati, flabellatim laciniati.

Sp. 1. *C. Moreaui*, Pomel; stipite oblongo, petiolorum residuis infimis patentibus, supremis adpressis, dorso valde carinatis.

Form. Jurassic. *Loc.* St. Michel, France.

Sp. 2. *C. Buvignieri*, Pomel; "An præcedentis varietas?" Pomel.

Form. Jurassic. *Loc.* St. Michel, France.

Tribus III. Williamsonieæ, trib. nov.

Flores masculi circa spadicem cylindricum aggregati; spadices feminei peltati, infundibuliformes, orbiculati, multifidi, ovula plura gerentes, 2 utrinque ad latera costæ segmenti symmetrice disposita.

Gen. 5. Williamsonia, gen. nov. Truncus cylindricus, stigmatibus petiolorum deciduorum cicatrisato-areolatus; folia lanceolata vel linearia acuminata, segmentis a baseos parte centrali supra rachidem impositis, marginibus liberis; flores terminales.

Sp. 1. *W. Gigas*, Carr.; foliis magnis lanceolatis vel ovato-acuminatis, basi attenuatis; segmentis numerosis, alternis, ovato- vel lineari-acuminatis, apice subfalcatis; nervis simplicibus parallelis, in margines liberos basales exigue divaricatis.

Form. Inferior Oolite. *Loc.* Scarborough, Yorkshire.

Sp. 2. *W. Pecten*, Carr.; foliis parvis linearibus apice et basi attenuatis; segmentis numerosis linearioblongis obtusis divergentibus, nervis simplicibus parallelis, in margines liberos basales exigue divaricatis.

Form. Inferior Oolite. *Loc.* Gristhorpe, Yorkshire.

Sp. 3. *W. hastula*, Carr.; foliis lanceolatis apice et basi attenuatis, segmentis numerosis lineari-lanceolatis, acutis, confertis, subimbricatis, patentibus; nervis parallelis in margines liberos basales exigue divaricatis.

Form. Inferior Oolite. *Loc.* Saltwick, Yorkshire.

Tribus IV. Bennettiteæ, trib. nov.

Flores masculi ignoti; feminei plurimi in ramulorum apice incrassato pulposo (e squamis carnosis connatis orto?) immersi.

Gen. 6. Bennettites, gen. nov. Truncus ovoideus, transverse ellipticus, petiolorum basibus persistentibus tectus; cylindrus ligneus, e vasis striatis in stratum interruptum coalitis, radiisque medullaribus separatis, compositus; fructus basibus petiolorum inclusus.

Sp. 1. *B. Saxbyanus,* Carr.; trunco elliptico, medulla ampla, cylindro ligneo sæpe interrupto tenui, fasciculis vascularibus petiolaribus e ligni maculis ortis, et per corticem amplum sursum postea divaricatim euntibus; petiolis subtriangularibus.

Form. Wealden. *Loc.* Isle of Wight.

Sp. 2. *B. Gibsonianus,* sp. nov.; trunco compresso-elliptico, medulla parva, cylindro ligneo rare interrupto, crasso, fasciculis vascularibus petiolaribus per corticem tenuem divaricatim euntibus, petiolis magnis rhomboideis.

Form. Lower Greensand. *Loc.* Isle of Wight.

Sp. 3. *B maximus,* sp. nov.; trunco elliptico, medulla ampla, cylindro ligneo sæpe interrupto tenuissimo, fasciculis vascularibus petiolaribus per corticem sursum postea divaricatim euntibus, petiolis magnis rhomboideis.

Form. Wealden. *Loc.* Isle of Wight.

Sp. 4. *B. Portlandicus,* sp. nov.; trunco oblongo-ovoideo, transverse elliptico, medulla parva, cylindro ligneo interrupto tenui, fasciculis vascularibus petiolaribus per corticem divaricatim euntibus, petiolis elongatis subrhomboideis.

Form. Lower Purbeck. *Loc.* Isle of Portland, Dorsetshire.

Sp. 5. *B. Peachianus,* sp. nov.; trunco transverse compresso-elliptico, magno, medulla amplissima, cylindro ligneo sparse interrupto, fasciculis vascularibus petiolaribus per corticem amplum divaricatim euntibus, petiolis rhomboideis lateraliter acuminatis.

Form. Middle Oolite. *Loc.* Helmsdale.

Gen. 7. Mantellia, Brongn. Truncus cylindricus, humilis vel erectus, petiolorum basibus persistentibus tectus; cylindrus ligneus e vasis striatis in stratum interruptum amplum coalitis, radiisque medullaribus separatis, compositus; fructus exsertus (in una specie inclusus).

Sp. 1. *M. nidiformis,* Brongn.; trunco oblongo-cylindrico crasso, extus petiolorum basibus persistentibus loricato, medulla ampla, cylindro ligneo crasso rare interrupto, cortice tenui, petiolorum basibus maximis rhomboideis angulis lateralibus productis.

Form. Lower Purbeck. *Loc.* Isle of Portland, Dorsetshire.

Sp. 2. *M. intermedia,* sp. nov.; trunco cylindrico, elongato, petiolorum basibus persistentibus tecto, medulla ampla, cylindro ligneo sæpe interrupto, cortice tenui, petiolorum basibus magnis rhomboideis.

Form. Lower Purbeck. *Loc.* Isle of Portland, Dorsetshire.

Sp. 3. *M. microphylla,* Miquel; trunco cylindrico, petiolorum basibus tecto, medulla ampla, cylindro ligneo sæpe sed tenuiter interrupto, cortice tenui; petiolorum basibus minoribus rhomboideis.

Form. Lower Purbeck. *Loc.* Isle of Portland, Dorsetshire.

Sp. 4. *M. inclusa,* sp. nov.; trunco cylindrico humili, petiolorum basibus loricato, medulla amplissima, cylindro ligneo sæpe interrupto, cortice amplo, fasciculis vascularibus petiolaribus farcto, petiolorum basibus minimis rhomboideis; fructibus inclusis.

Form. Lower Cretaceous. *Loc.* Potton, Bedfordshire.

Gen. 8. Raumeria, Göpp. Truncus cylindricus, squamis, petiolorum basibus persistentibus squamulisque stipulæformibus inter sese connatis dense tectus vel cicatrisatus.

Sp. 1. *R. Reichenbachiana*, Göpp.; cicatricibus petiolorum trigonis remotis angulis obtusis, cicatriculis inter eas in quincunce dispositis minutis subtrigono-rhomboideis.

Form. Ignota. *Loc.* Wieliczka, Gallicia.

Sp. 2. *R. Schulziana*, Göpp.; cicatricibus petiolorum transverse subrhomboideis remotis angulis lateralibus acutis, superiore et inferiore obtusis, cicatriculis inter illas in quincunce positis subtrigonis rhomboideis.

Form. Ignota. *Loc.* Gleiwitz, Silesia.

I. Bucklandia.

1825. *Bucklandia*, Presl, Tent. Flor. Primord. p. xxxiii. in Sternb. Flor. der Vorwelt.
1828. *Clathraria*, Brongn. Prodr. p. 128 (non Brongn. Mém. du Mus. vol. viii. p. 209, 1822).
1828. *Bucklandia*, Brongn. Prodr. p. 128.

Trunk cylindrical, sometimes bifurcating, reticulate, with the scars of the bases of the leaves, which are arranged in alternating series of large and small scars, the large being placed on swellings and the small on constrictions of the stems. *Andræcium* a cone (?). *Gynæcium* a terminal crown of leaves bearing the seeds on their somewhat altered margins.

The name *Clathraria* was first employed by Brongniart in 1822 for a section of Sternberg's genus *Lepidodendron*, differing from the group to which the name *Sigillaria* was afterwards applied in being without parallel furrows on the stem. Stokes and Webb, in their Report on Mantell's Vegetable Fossils from Tilgate Forest [1], referred one of them to Brongniart's *Clatharia*; but, to indicate that they considered it very different from the Lepidodendroid fossils included in that genus, they gave it the specific designation *anomala*. Presl, in the Revision of Fossil Plants prefixed to Sternberg's 'Flora der Vorwelt' (1825), separated Mantell's Tilgate fossil from Brongniart's *Clathraria* (which he rightly placed among the Cryptogamia), and established the genus *Bucklandia* for it, referring it with remarkable discrimination to *Cycadeæ*. Brongniart, in his 'Prodrome,' in 1828, permitted his original genus *Clathraria* to disappear in *Sigillaria*, but nevertheless retained the name to designate a section of that genus in another work published in the same year [2]. Notwithstanding this, he reintroduced the name in the 'Prodrome' for a new genus created for the Tilgate fossil, even although he was aware that Presl had already separated it generically; for he quotes *Bucklandia*, Sternb., as a synonym of his new genus. This confusion is further increased by the adoption in the same work of *Bucklandia* for an Oolite fossil from Stonesfield, figured and described in Sternberg's 'Flora' as *Conites Bucklandi*, which Brongniart considered to be the type of a new genus allied to, yet different from, his new *Clathraria*. Both genera were referred by him to *Liliaceæ*, being compared to the stems of some arborescent members of that Order, especially to *Xanthorrhœa*. In 1849 [3] he adopted Presl's interpretation, and placed them among the *Cycadeæ*.

I have examined the original and, as yet, only specimen of Sternberg's *Conites Bucklandi*, preserved in the Oxford Museum, and am satisfied that it is truly Cycadean, and that its nearest allies are the plants referred to *Clathraria*. I therefore do not hesitate to

[1] Geol. Trans. ser. 2, vol. i. p. 422 (1824).
[2] Histoire des Végétaux Fossiles, vol. i. p. 430.
[3] Tabl. des Genr. de Vég. Foss. p. 91.

refer Brongniart's *Bucklandia*, along with his *Clathraria*, to Sternberg's older genus of the same name. The original *Clathraria* is still retained by some palæontologists as a good genus of palæozoic vascular cryptogams[1].

Dr. Mantell gave up his first vague notions of the affinities of these fossils after the publication of the report by Stokes and Webb, when he referred them, with these authors, "to the same tribe of fossil plants as the *Lepidodendron* of Sternberg," "a tribe of vegetables of the ancient world which is common in the Carboniferous strata, and appears to have held an intermediate place between the Equiseta and the Palms."[2] In order that his readers might the more clearly realize the aspect of the fossil, he reproduced a figure of Sternberg's *Lepidodendron dichotomum*, in which the form and attachment of the leaves are shown. Some years later[3] he adopted the opinion of Brongniart, and held that they approximated "very nearly to *Dracæna*, or rather to *Xanthorrhœa*." He maintains this view of their affinities in his numerous publications[4] which so largely contributed to make the new science of Geology popular, until 1847, when "the discovery of more illustrative specimens than those at first obtained indicated their affinity to the *Cycadeæ*, with which M. Brongniart has some years since arranged them"[5]. These specimens, however, were water-worn fragments of a very distinct genus (*Bennettites*), the nature of which I have been able to determine from the large series of specimens which I have had the opportunity of examining.

Bucklandia is known only from the impressions of the stems and of the medullary axis of the various species. All the specimens I have seen are casts in the amorphous substance of the rock in which they are imbedded. Mantell says:—"In the strata of the Tilgate Forest the *Clathrariæ* are invariably associated with water-worn bones of reptiles, pebbles, gravel, and other drift, and are often imbedded in the fluviatile conglomerate which is found in some parts of the Wealden. They appear to have floated down the river with the carcasses and limbs of the reptiles, and at length to have sunk to the bottom, and become imbedded in the mud of the Delta"[6]. The large medulla of the buried stem first yielded to decay; and into the cavity thus formed the amorphous mud was pressed, moulding itself on the interior of the woody cylinder. Subsequently the whole of the more indurated tissues perished, and their place was filled with more of the mud, which received the impression of the outer surface of the stem with all its characteristic markings. Consequently no information regarding these fossils can be obtained by the use of the microscope; all must be gathered from the markings impressed on the structureless casts.

The stems were cylindrical, attaining a height of at least four feet, and sometimes dividing dichotomously. In one specimen a second dichotomizing is shown, so producing three equal branches. The stem exhibits a series of alternating swellings and constrictions, and is covered with more or less rhomboidal scars arranged in close proximity to each other, and in a quincuncial manner. The appendages borne by these scars have

[1] Dawson, Acadian Geology (1868), p. 435.
[2] Geology of the South-east of England (1833), p. 235.
[3] Illustrations of the Geol. of Sussex (1827), p. 32.
[4] The Wonders of Geology (1838), p. 342; The Medals of Creation (1844), p. 184, &c.
[5] Geology of the Isle of Wight (1847), p. 292.
[6] The Wonders of Geology, ed. vi. p. 398.

disarticulated near the stem, as in *Cycas* and *Zamia*, and have not left any length of permanent bases of the petioles surrounding the axis like what is seen in *Encephalartos* and some fossil genera. The scars are not all of the same size. Those on the swollen portions of the stem are large and rhomboidal, while on the constrictions they are as broad, but much less deep. The whole surface of the large scar forms the cicatrix from which the appendage which it bore has been broken off. The scars on the lower half of the constricted portions of the stem are smaller than those on the upper half, being from six to eight times as broad as deep; they are slightly imbricated, and the cicatrix is confined to the upper margin. The scars on the upper portion of the constriction are from two to four times as broad as deep, and the cicatrix extends over the whole exposed surface.

Besides these impressions of the outer surface of the stem, there are found sometimes enclosed in them, but more frequently independent of them, cylindrical columns covered with interrupted longitudinal ridges. These ridges represent the meshes or openings in the woody cylinder through which the vascular bundles passed to the leaves. Such openings are found in all dicotyledons, but are especially obvious in those which have a large medulla associated with a slender wood-cylinder and numerous large leaves, as in *Tupa* and in the *Cycadeæ*. It is only in the *Cycadeæ* that such markings are associated with the rhomboidal scars described as characteristic of the outer surface of the stem. So exactly, indeed, do the corresponding parts agree, as far as they can be compared, that there can be no doubt that *Bucklandia* was built upon the same plan as *Cycas*. The best species for comparison is *C. circinalis*, Linn., not only because it is often met with in cultivation, but chiefly because Miquel has, in an elaborate memoir[1], investigated the cause of the swellings and constrictions, and the different forms of scars associated with them on the stem of this species. He shows that they are produced by the peculiar terminal inflorescence of the plants. The seeds are borne on the margins of altered leaves, and the terminal crown of the fruit-bearing leaves is separated from the true leaves by a large number of lanceolate scales arranged in the same series with the leaves. In *C. circinalis* no scales occur among the true leaves, they are entirely confined to the constricted portion of the stem. The differences in the size of the stem are the results, according to Miquel, of the different appendages borne upon these different parts. The internodes are not developed in the stem of *Cycas*, so that when the bud is completely formed the axis does not lengthen. It increases, however, in diameter during its whole life, chiefly by the development of the cortical parenchyma; and as this is intimately related to the scales and leaves, the true leaves develope more than the scales or fruit-bearing leaves, and consequently produce a greater thickness in the portion of the stem immediately connected with them.

The remarkable correspondence between the recent and the fossil stems, both belonging, as there can be no doubt, to the same order of plants, may fairly be inferred to have been produced by the same cause:—that the large scars are the bases of true leaves; the smaller scars immediately succeeding them, as is established by their slight imbrication and the small cicatrix on their upper margin, supported lanceolate scales; and the somewhat larger-

[1] Linnæa, vol. xviii. (1844) p. 125, pls. iv.–vi. Translated by Brongniart, and published in the Ann. des Sc. Nat. ser. 3. vol. v. p. 11.

sized scars on the upper portion of the constriction were produced by the bases of the fruit-bearing leaves[1].

The absence of seed-bearing cones in the beds in which these stems occur, and the not unfrequent occurrence of separate seeds agreeing in form and in the position of the scar of attachment or hilum with those of *Cycas*, are further corroboration of the probability of this estimate of their affinity.

The only certain indication of the antheriferous organs of fossil Cycads which I have seen from British strata, is a fragment of a cone found by S. R. Pattison, Esq., F.G.S., in the same series of strata as those in which *Bucklandia* occurs, although not at the same locality. He found it in one of the beds of the Hastings sands, a little to the east of the harbour rocks, Hastings. The fragment (Tab. LIV: fig. 6) represents a portion of the centre of a cone, compressed somewhat obliquely. A part of the axis is exposed, exhibiting the surfaces of attachment of rather more than twenty scales. The substance of the cone is converted into jet; but the forms of the axis and scales are preserved in the white mud which has penetrated into every opening. The axis is thick, and the scales elongate-cuneiform, with a subtruncate apex terminating in a short apiculus. The phyllotaxy of the scales in the cone, as seen on the portion of the axis, is that found in Cycadeæ; and the thin, flat scale agrees in form with the antheriferous scale in the cones of various species of the genus *Cycas*.

The connexion of the male and female organs with *Bucklandia* has, of course, not been established by the only absolutely certain evidence, the discovery of the various parts organically connected. It is seldom that the student of palæontological botany is fortunate enough to find the materials of his study so perfect. He is consequently often compelled to establish distinct genera for the various parts of a plant which differ from each other in form and appearance—as for roots, stem, branches, leaves, and fruit. The fortunate, but very rare, discovery of a perfect specimen, sometimes enables him to correlate their detached parts, and to reduce the temporary genera; but in the great majority of cases he must be guided entirely by the morphological laws deduced from the study of the living vegetable world when seeking to trace the relationship between separated fragments of plants buried together in the same locality or in beds of the same age. If the interpretation I have given of the stem of *Bucklandia* be correct, and if there is good reason, from a morphological point of view, for connecting with it the seeds and male cone found in the same beds, we have a plant which, in these known particulars, cannot be separated generically from *Cycas*.

From the absence of structure in all the specimens yet discovered of *Bucklandia*, there is no evidence as to the presence of canals for the secretion of the mucilaginous juice which is so abundant in the living *Cycadeæ*. But our specimen of *B. anomala* (Tab. LIV. fig. 3) preserves on its surface the casts of large drops of this substance, that had exuded and hardened, so as to mould the rock around them; and so rich was this fossil in the gum, that, in this specimen, the interspaces between the scales are filled up with it.

[1] The cylindrical stem of *Microcycas calocoma*, DC., a remarkable Cycad from Pine Island, near Cuba, exhibits a series of uniform scales alternating with true leaves; but the two kinds of small scars, produced by the scales and the fruiting leaves, easily distinguish the stem of *Microcycas* from those of *C. circinalis* or *Bucklandia*.

BUCKLANDIA ANOMALA, Presl, Tent. Flor. Primord. p. xxxiii. in Sternberg's Flora der Vorwelt (1825). (Tab. LIV. fig. 1–3.)

1822. "Stems of Vegetables," Mantell, Fossils of the South Downs, p. 42.
1824. *Clathraria anomala*, Stokes & Webb, Geol. Trans. ser. 2, vol. i. p. 423, pl. xlv. figs. 1 & 3.
1827. *C. Lyellii*, Mantell, Geol. of Sussex, p. 52, pl. i. fig. 2; pt. ii. figs. 4 & 5.
1828. *Clathraria* (gen. nov.) *Lyellii*, Brongn. Prodr. p. 126.

Scars of the leaves subrhomboidal, the lateral angles more or less truncate, inferior angle acute, the superior obtuse or somewhat rounded. The surface of the scar in some specimens marked with a triradiate ridge. The smaller scars oblong, with blunt lateral angles, obtuse inferior, and slightly rounded, almost straight superior angle; the scars equal in breadth to the larger ones, but not nearly so deep; the cicatrix on the upper margin. The bases of the leaves are set somewhat obliquely on the stem, their upper margin following the direction of the right-hand spiral. Each series of leaves occupies a considerable length of the stem. The phyllotaxy is represented by the fraction $\frac{5}{13}$.

From the Hastings Sand at Cuckfield, Sussex, *Dr. Mantell*. [British Museum and Museum of Practical Geology.]

The name given to this species was set aside by Mantell for a manuscript name *C. Lyellii*, which he had applied to the fossil before the publication of Stokes and Webb's report, claiming, as he says, "the privilege of original discoverers to retain that specific designation."—*Geol. Suss.* p. 52.

B. MANTELLII, sp. nov. (Tab. LIV. fig. 4.)

1824. *Clathraria anomala*, Stokes & Webb (in part), Geol. Trans. ser. 2, vol. i. p. 423, pl. xlvi. fig. 2, pl. xlvii. fig. 4 *a*.
1827. *C. Lyellii*, Mantell (in part), Geol. of Sussex, pl. ii. fig. 2; pl. iii. fig. 4 *a*.

Scars of the leaves rhomboidal, the lateral angles acute, the inferior and superior angles obtuse, the latter somewhat rounded. The small scars equal in breadth to the large ones, and increasing in depth from the bottom of the constriction upwards. Each swelling of the stem bearing three or four series of leaves, the constricted portion much longer, and crowded with the smaller scars, forming twelve or fourteen vertical series. The bases of the leaves set horizontally on the stem. The phyllotaxy is represented by the fraction $\frac{5}{13}$.

From the Hastings Sand at Cuckfield, Sussex, *Dr. Mantell*. [British Museum.]

The casts of the axis, which are more abundant in the Iguanodon-quarries than specimens showing the outer surface of the stem, cannot yet be referred to either species. Judging from the differences in the size and form of the swellings (which are the casts of the meshes of the woody cylinder), it seems probable that the large series of these cores in the British Museum collection may belong to three or four distinct species.

B. SQUAMOSA, Brongn. Prodr. p. 128 (1828).

1825. *Conites Bucklandii*, Stern. Flora der Vorwelt, fasc. iii. p. 39, tab. 30.
1828. "Amentum of Cycas," Buckland, Geol. Trans. ser. 2, vol. ii. p. 400.

1838. *Cycadites Bucklandi,* Presl in Stern. Flora der Vorw. fasc. vii. & viii. p. 194.
1849. *Cycadoidea squamosa,* Brongn. Tabl. Vég. Foss. p. 106.

This species is known only from a single specimen found in the great Oolite of Stonesfield, Oxfordshire. It is a fragment of the growing end of an axis, the upper portion of which is covered with triangular scales, like those in species of *Zamia* or *Encephalartos*, and the lower portion exhibits the small, regular meshes or reticulations of the woody cylinder, the scales and cortical layer having been broken away. The materials are insufficient to distinguish it from the other species, or even to refer it with certainty to its proper genus; but the great difference between its age and that of any of the other allied forms warrants the retention of the name and the recognition of it as a species.

From the Stonesfield Slate. [University Museum, Oxford.]

When Sternberg figured this fossil, he referred it to *Coniferæ*, comparing it with the cone of *Pinus Abies*, Linn. Presl, in recording it in his *Tentamen* (p. xxxix) among coniferous cones, suggests that it is more probably Cycadean; he afterwards placed it among the *Cycadeæ* under the name *Cycadites Bucklandi*. Buckland thought it might be the amentum of one of his fossil species. Brongniart placed it originally in *Liliaceæ* (Prodr. p. 128), but afterwards referred it to its true position (Tabl. p. 106).

B. Milleriana, sp. nov. (Tab. LV. fig. 1.)

Scars of the leaves subrhomboidal, agreeing in form with those of *B. anomala*, but much smaller. The smaller scars compressed-rhomboidal, sometimes marked with a horizontal line across the middle of the scar. The phyllotaxy is represented by the fraction $\frac{8}{21}$.

From the Coral Rag at Brora, Sutherlandshire, *Hugh Miller* [Edinburgh Museum], *Rev. J. M. Joass* [Dunrobin-Castle Museum].

There is, in the collection of Mr. C. W. Peach, a fragment of what appears to be another species, characterized by having the scars deeper than broad; but the materials are not sufficient to distinguish it satisfactorily.

II. Yatesia, gen. nov.

Trunk cylindrical, of uniform thickness, and covered with the short persistent bases of the petioles; scars of the aborted leaves scattered among those of the true leaves. *Androecium* unknown; *gynœcium* forming a cone, each carpophyll of which bears two reflexed ovules.

No bud of specialized fruit-bearing leaves could have been borne on the main axis of the stems grouped together in this genus. The scars are nearly equal in size; and the somewhat smaller scars of the aborted leaves occur irregularly amongst the ordinary leaves, but in the same series with them. In one species (*Y. Morrisii*) the medulla was penetrated with vascular bundles, as in the living members of the tribe *Encephalarteæ*. The condition in which the specimens of the other species are preserved makes it impossible to discover what was the nature of their pith. Numerous Cycadean fruits occur in

the Secondary rocks. Many of them I have already figured and described[1]. They are cones composed of stipitate and peltate carpophylls, each bearing two reflexed ovules, as in *Encephalartos*, *Zamia*, &c., but agreeing, as regards their small size, with the fruits of the New-World *Zamieæ*. As these cones do not belong to *Bucklandia*, nor, as I shall presently show, to *Bennettites* or *Mantellia*, it is probable that they are the fruits of *Yatesia* and *Fittonia*. This supposition is strengthened by the following considerations:—1st, the structure of the stems appears to require deciduous axillary appendages for the organs of reproduction; 2nd, one of these cones (*Cycadeostrobus Walkeri*, Carr.) has been found in the same stratum in which the stem of *Yatesia Morrisii* is found; and, 3rd, the British Museum contains stems of two species of *Yatesia*, and a cone having the same structure as those included in *Cycadeostrobus*, from the Oolitic Argile des Dives of France. If these considerations are sufficient to warrant us in referring the fruits included under the name *Cycadeostrobus* in part to *Yatesia*, this genus accords with *Encephalartos* in the structure of the female cone, as well as in the presence of vascular bundles in the medulla, and in the permanent investment of the stem by the bases of the petioles. Only in the small size of the fruit does it differ from the African genus, this character suggesting an approach to *Zamia*.

The following forms most probably belong to this genus:—*Mantellia cylindrica*, Brongn., Prodr. p. 96; *Bucklandia gracilis*, Pomel, Amtlich. Bericht. d. Gesell. d. Nat. in Aachen, 1847, p. 346; *Echinostipes Duvalii*, Pomel, *l. c.* p. 346.

The genus is dedicated to James Yates, Esq., F.R.S., whose extensive and accurate acquaintance with *Cycadeæ*, and whose large collection of plants of this order, are well known. I am indebted to him for information, at all times cordially given, for free access to his collections, and especially for the use I have been able to make of his extensive series of dried stems, leaves, and seeds, which he has presented to the herbarium of the British Museum since I began these investigations.

Yatesia Morrisii, Carr. (Tab. LV. fig. 3–6.)

1867. *Cycadeoidea Yatesii*, Morr. & Carr. Geol. Mag. vol. iv. p. 199, pl. ix.

Stem cylindrical, covered with the bases of the petioles, which are rhomboidal in form, and terminate in a tumid boss, the apex of which is directed upwards. The cellular axis is very large. The pith has disappeared, except in one specimen, where sufficient of it remains to show that it was permeated with vascular bundles. The woody cylinder surrounding the pith, in the specimen figured, consists of two rings (figs. 5 & 6); it is everywhere pierced by medullary rays, which are often so large as to break the continuity of the wood (fig. 6). The sides of the wood-cells parallel to the medullary rays are covered with disks in two or three rows (Tab. LX. fig. 13). The inner surface of the woody cylinder exhibits numerous narrow grooves, being the meshes for the passage outwards of the vascular bundles to the leaves. These meshes are larger and more regular on the outer surface of the wood. A very thin layer of cortical cellular tissue separates the wood from the base of the petioles. The bases of the petioles spring from this layer, at right angles to the stem. Externally they

[1] Seemann's Journal of Botany, vol. v. p. 1, pl. 1.

present a rhomboid form, the horizontal diameter of which is but little more than the perpendicular.

All the specimens of this fossil are found in the iron and green sands of Potton, Bedfordshire (Lower Greensand), in a sand-pit just outside the town of Leighton-Buzzard, to the north-east. They are converted into a rich brown hematite. The figured specimen is in the Museum of the Royal Agricultural College, Cirencester. I have received specimens from Mr. Yates, Prof. Morris, and Prof. Rupert Jones, which are now deposited in the British Museum.

In associating the name of Prof. Morris with this species, I desire to record my sense of the great value of his critical observations on the species of British Fossil *Cycadeæ*, and to acknowledge the debt I owe him for his numerous important verbal communications on the subject of this paper, and his information regarding memoirs in little-known periodicals which would otherwise have escaped my observation.

Y. GRACILIS, sp. nov. (Tab. LV. fig. 2.)

Stem cylindrical, very slender, covered with the permanent bases of the petioles, which are imbricated, subrhomboidal, and terminated by a lozenge-shaped cicatrix.

From the Lias of Lyme Regis. [British Museum.]

The only specimen yet discovered of this fossil is somewhat flattened, and remains half buried in its original matrix, so that it cannot be examined completely. No indication of the internal structure of the stem remains; but the form and arrangement of the persistent petioles is sufficient to determine its nature. The scar of an axillary organ, perhaps (from its small size) the peduncle of a cone, is seen on the upper part of the stem. A less perfect indication of what may have been a forking of the stem is seen towards the base of the specimen.

Y. CRASSA, sp. nov. (Tab. LV. fig. 7.)

Stem short, subcylindrical, covered with the persistent imbricated bases of the petioles, which are transversely subovoid or imperfectly lozenge-shaped. The phyllotaxy is represented by the fraction $\frac{5}{13}$.

From the Coral Rag of Brora, Sutherlandshire, *Rev. Jas. M. Joass.* [Dunrobin-Castle Museum.]

The single fragment of this species which I have seen is imperfect, but it presents characters sufficiently distinct to warrant its being named and described. It is a cast of the stem in white sandstone. No traces of the different parts of this stem are shown, except the short thick imbricated bases of the petioles.

Y. JOASSIANA, sp. nov. (Tab. LV. fig. 8 et 9.)

Stem cylindrical, slender, branching dichotomously, covered with the bases of the petioles, which are subrhomboidal or lozenge-shaped, and slightly imbricated. The phyllotaxy is represented by the fraction $\frac{5}{13}$. The cast of the woody axis is marked with interrupted longitudinal grooves.

From the Coral Rag of Brora, Sutherlandshire, *Rev. Jas. M. Joass.* [Dunrobin-Castle Museum.]

This is a well-marked species. In the middle of the stem (fig. 8) there is the scar of a peduncle, which has been surrounded by a series of small scales, giving to the stem somewhat the appearance of the living West-Indian *Microcycas calocoma*, DC. The scar on the opposite side (fig. 9) is evidently produced by the dichotomous division of the stem.

Hugh Miller, in his 'Testimony of the Rocks' (p. 476), has described several forms of Cycadean foliage from the beds in which this species and *Y. crassa* were found; but there are no means of correlating any of them with these stems.

III. Fittonia, gen. nov.

Trunk short obovate; woody axis slender, enlarging upwards; cortical layer large. *Scales* and bases of the petioles large, imbricated, at first reflexed, then ascending.

The bases of the petioles are few in number in proportion to the scales, and occur irregularly amongst them, though both organs are arranged in the same series. Neither fruit nor foliage has been found associated with this fossil; but from its striking affinity in those characters in which it can be compared with the South-African *Encephalartos*, I cannot hesitate in placing it with *Yatesia*, near that genus.

F. squamata, sp. nov. (Tab. LVI.)

1847. *Clathraria anomala* (in part), Mantell, Isle of Wight, p. 295, Lign. 23 & 24.

Scales oblong, with an obtusely rounded apex; bases of the petioles contracted below the plane of articulation; cicatrix showing a continuous series of vascular bundles parallel to the margin, except in the median line of the upper surface, where a large loop penetrates into and beyond the centre of the petiole. The phyllotaxy is represented by the fraction $\frac{8}{21}$.

From the Chalk Marl at Bonchurch, Isle of Wight, according to Mantell, but believed by Mr. Etheridge, from the condition of its mineralization and the character of the rock in which it has been imbedded, to be from the Wealden at Brook, *Capt. Ibbetson.* [Jermyn-Street Museum.]

The only specimen hitherto found of this fossil is a singularly perfect cast of the stem. The cavity originally occupied by it has been filled with the amorphous substance of the rock in which it was buried; and the cast thus made is so perfect that the external markings of the scales and petioles and the impressions of the vascular bundles are exhibited; while each scale, though closely adpressed to its neighbours, is yet free from them even at its base. The original organism must have been incrusted with a crystallized mineral, like calcite, which, after the decay of the vegetable tissues, received and moulded the amorphous matter of the cast. This mineral has been redissolved and carried away, so that what remains is a remarkable facsimile of the original, as far as the outer surface is concerned.

IV. Crossozamia, Pomel.

Crossozamia, Pomel, Amtlicher Bericht. xxv. Versam. d. Gesellsch. deutsch. Nat. und Aerzte in Aachen, 1847, p. 342.

Trunk oblong-ellipsoid, covered with the short subimbricated persistent bases of the petioles. *Leaves* petiolate and pinnate, with linear-lanceolate or oblong pinnæ, contracted at the base. *Fruits* in a

strobilus, consisting of imbricate, adpressed, lanceolate and pedicellate scales, which are deeply cut in a flabellate manner into linear lobes, and bear two seeds, one on each side of the pedicel.

The stems belonging to this genus are like those of *Mantellia*, only longer, and the bases of the petioles are shorter and imbricated. The fruit is known only from the scales and seeds found associated in the same bed, and correlated by M. Pomel, as well as built up by him into a cone. He considers the genus closely allied, from the structure of its fruit, to *Dion*.

C. Moreaui, Pom. *l. c.* p. 343 (erroneously printed *moreana*).

Cycadites Moreaui, Brongn. Tabl. Genr. Foss. p. 62.

Fronds broadly oblong; petiole long and thick; pinnæ linear-lanceolate, attenuated, acute, contracted at the base, approximate; veins strong, numerous, parallel, and simple; seeds ovoid, with a somewhat attenuated bluntish apex; trunk oblong, the bases of the lower petioles patent, of the upper adpressed.

Form. Jurassic. *Loc.* St. Michel, France.

The second species from the same beds described by M. Pomel (*C. Buvignieri*) is probably, as he himself supposes, only a variety of *C. Moreaui*.

M. Pomel refers several imperfectly known plants with greater or less hesitancy to this remarkable genus. He considers the fruits from the Stonesfield Slate, figured by Sternberg under the name *Carpolithes diospyriformis*, and afterwards, without a name, by Lindley and Hutton, in their 'Fossil Flora' (Plate 193, A 1–4), as belonging to *Crossozamia*. In the large series of organic remains from the Stonesfield Slate, which I have examined in the British Museum, the Oxford Museum, and the Collection of the Rev. P. B. Brodie, I have seen nothing like what he describes as the scales of the cones. One, if not two forms of Cycadean leaves, occurs in this deposit, at Stonesfield, and the fragment of a stem has also been found (*Bucklandia squamosa*, Brongn.); but their characters do not accord with the diagnosis given by M. Pomel of his genus.

V. Williamsonia, gen. nov.

Zamiæ, Zamitis, Podozamitis, Pterophylli, Palæozamiæ, Encephalarti, Dionitis species auctorum.

Stem cylindrical, elongated, marked with the equal-sized, tumid, rhomboidal scars of the fallen leaves. *Leaves* ovate-lanceolate or linear-acuminate, segments numerous, attached to the rachis by the central portion, with small free margins; *veins* numerous, parallel, at the base slightly diverging into the free margins. *Flowers* terminal, stamens surrounding a fleshy axis, ovules borne on the upper surface of an orbicular laciniate spadix.

The remarkable organisms referred to this genus have been the subjects of much curious and interesting speculation. Young and Bird[1] give the earliest figure of *W. Gigas*. These authors associate the male inflorescence with the leaf, as "apparently the head of the plant," and then compare it to the inflorescence of the "Artichoke, *Cynara integrifolia*, the covering or calyx consisting of numerous lanceolate and striated leaves, partly lying over one another."

[1] Geology of the Yorkshire Coast, plate ii. figs. 2 & 6 (1822).

Mr. Yates, in a notice of this plant published in the 'Proceedings of the Yorkshire Philosophical Society' for 1847 (p. 37), describes the inflorescence as consisting of a number of scales resembling sepals, petals, or perhaps dilated stamens, all growing from the top of the fruit-stalk, and overlapping one another. They surrounded an oval or pyriform cavity, which he thinks may have contained the germen.

Prof. Williamson[1], in the same year, suggested that the axis above the collar of leaves supported a cone, which had been always broken off. M. Brongniart, to whom Mr. Yates communicated his large series of specimens, and Prof. Williamson his accurate drawings, was unable to determine their affinities. He considered them to belong to an extinct type, so different from any known Cycad that it is very difficult to understand them. He further considers that the buds present some analogies to the fruit of *Podocarya*, a Pandanaceous fossil from the Inferior Oolite near Charmouth, Dorset[2]. In endeavouring to form an estimate of these puzzling organisms, after having examined the extensive series in the British Museum, I visited Scarborough, and examined the fine collection in the museum there, as well as that belonging to Mr. Leckenby; I also visited the museum at York, and examined the yet finer series belonging to Prof. Williamson, who, after having these fossils under his notice for thirty-six years, in the most liberal and disinterested manner, when he heard that I was working at them, offered to place his drawings and manuscripts at my service. The number of facts he had collected, and his ingenious interpretation of them, seemed to me too important to be incorporated in the work of another; and I was fortunate enough to obtain from him the paper which precedes this memoir, for communication to the Society. He has introduced a clearer apprehension of the different forms of the supposed organs of reproduction, by the suggestion that the two kinds represent the different sexes, and by the discovery of a seed-bearing spadix. While I see serious difficulties in associating flowers so different in their structure, and in their relation to the supporting axis, as those belonging to *W. Gigas* according to Prof. Williamson's interpretation, I am unable to suggest any view of them which would present fewer difficulties. The discovery of a male inflorescence exhibiting the internal structure would be of immense value; hitherto the numerous specimens have done little more than show the external form. The elaborate exposition of these organs in the memoir preceding this relieves me of entering further into their description.

In proposing the name *Williamsonia*, I have ventured to associate with a group of the most characteristic Yorkshire fossils two men (father and son) who have largely contributed to the exposition of Yorkshire geology.

Oldham and Morris, in their account of fossil plants of the Rajmahal Hills[3], describe organisms associated with the foliage and stems of Cycadeæ, which agree with the inflorescence of *W. Gigas*. One specimen is a "striated or fibrous disk, formed of an aggregation of closely packed tubes, arranged in a circle around a central hollow; the outer margin is somewhat irregular. The appearance of striation is due to a congeries of closely packed tubes or long linear vessels." This agrees with the male inflorescence of the English species, and is a singular confirmation of Prof. Williamson's interpretation of it.

[1] Proc. York Phil. Soc. 1847, p. 45.

[2] Tabl. Genr. Foss. pp. 62, 88.

[3] Palæontologia Indica, vol. ii. part 1, pp. 30, 32, & 36, pls. xxi., xxxii. fig. 12, & xxxiv.

Another specimen is described as "a circular disk, which gives rise to a series of about twelve long lanceolate bracts or leaves, striated, approximate at their base, and separate at their apices," and is probably the female spadix. The foliage associated with these fossils, described under the name *Palæozamia Cutchensis*, Morris, is very near to *W. Pecten*, and agrees with that and the other species of *Williamsonia* in having the segments attached by the centre, with free basal margins. The stems also are slender and cylindrical, covered with the tumid cicatrices of the petioles, and agreeing in form and arrangement with the specimen of the stem of *W. Gigas* which I examined in the Cambridge Museum. The stems are described as having, at irregular intervals, bands of smaller scars. A specimen in the British Museum shows one of these bands, which have been produced by scales or aborted leaves, that were most probably borne on the main stem, below the origin of the peduncle.

Emmons has described[1] a rich Cycadean flora from the Atlantic slope of North Carolina, which he considers to be of Triassic age, but which seems to me more probably Jurassic. Among these remains he describes leaves, stems, and disks, which probably belong to this genus: but specimens, or at least more accurate drawings, are needed before any satisfactory judgment can be formed regarding them.

Williamsonia Gigas, Carr.

1822. "A Plant," Young and Bird, Geology of Yorkshire, p. 183, plate ii. figs. 2–6.
1837. *Zamia Gigas*, Lindl. & Hutt. Fossil Flora, pl. 165.
1841. *Zamites Gigas*, Morris, Ann. Nat. Hist. vii. p. 116.
1842. *Encephalartos Gigas*, Miquel, Monogr. Cycad. p. 61.
1849. *Podozamites Gigas*, Brongn. Tabl. Genr. Foss. p. 62.
1838. *Odontopteris falcata*, Sternb. Fl. d. Vorwelt, fasc. v. & vi. p. 78, tab. xxiii. fig. 1.
1838. *Zamites falcatus*, Presl, Sternb. Fl. d. Vorw. fasc. vii. & viii. p. 97.
1841. *Ptilophyllum falcatum*, Morris, Ann. Nat. Hist. vii. p. 118.
1843. *Palæozamia falcata*, Morris, Cat. Brit. Foss. p. 15.
1849. *Podozamites falcatus*, Brongn. Tabl. Genr. Foss. p. 12.
1828. *Zamia Mantellii*, Brongn. (nomen), Prodr. p. 94 (fide Brongn. Tabl. Genr. Foss. p. 62).

Leaves large, lanceolate, or ovate acuminate, attenuate at the base; segments numerous, closely approximated, but not touching, lanceolate acuminate, subfalcate at the apex; veins many, simple, parallel, slightly divaricating into the free margins of the base.

This species forms the subject of Professor Williamson's exhaustive memoir, and is fully illustrated in the accompanying plates.

From the Inferior Oolite, near Scarborough, Yorkshire. [British Museum, &c.]

W. hastula, Carr.

1864. *Palæozamia hastula*, Bean, MS. Leckenby on Oolitic Plants, Quart. Journ. Geol. Soc. vol. xx. p. 77.
1829. *Cycadites pectinoides*, Phillips (non Sternb.), Geol. of Yorkshire, p. 125, pl. x. f. 4.

Leaves linear-lanceolate, attenuate above and below; segments numerous, linear-lanceolate,

[1] American Geology, part vi. pp. 112–125 (1857).

crowded, slightly overlapping, patent, veins parallel, divaricating into the free margins at the base of the segment. Segments of the female spadix narrow, elongate.

The female spadix associated with the leaves of this species is intermediate in size between that of *W. Gigas* and of *W. Pecten*, and the segments are longer and narrower than in either. The species has been confounded with a plant from the Stonesfield Slate (*Palæozamia pectinata*, Morris), which is certainly different.

From the Inferior Oolite at Saltwick, Yorkshire. [British Museum.]

W. Pecten, Carr.

1829. *Cycadites pecten*, Phillips, Geol. York. p. 125, pl. vii. f. 22.
1837. *Pterophyllum pecten*, Lindl. & Hutt. Foss. Flora, pl. cii.
1841. *Ptilophyllum pecten*, Morris, Ann. Nat. Hist. vii. p. 117.
1843. *Palæozamia pecten*, Morris, Cat. Brit. Foss. p. 15.
1861. *Dionites pecten*, Miq. Prodr. Syst. Cyc. p. 31.
1838. *Odontopteris Bucklandi*, Sternb. (non Brong.) Flora, fasc. v. & vi. p. 79, pl. xxiii. fig. 2.
1838. *Zamites Bucklandi*, Presl, Sternberg, Flora, p. 197.

Leaves linear, attenuated above and below, segments numerous, oblong, obtuse, subdistant, divergent, veins parallel, slightly divaricating into the small free margins at the base. Segments of the female spadix broad and short.

Mr. Leckenby has figured[1] the female spadix, and in his collection there is a reticulate structure which Prof. Williamson refers to the male inflorescence. Specimens of both organisms exist in the British Museum, associated with the leaves of this species, as well as a number of separate triangular bodies which I cannot distinguish from the segments of the spadix separated at the base of the free portion, and bearing on the surface of their broad base two seeds similar in size and form to those figured by Prof. Williamson in connexion with *W. Gigas*.

From the Inferior Oolite at Gristhorpe Bay, Yorkshire.

VI. Bennettites, gen. nov.

Trunk ovoid, in transverse section elliptical, covered with the somewhat long permanent bases of the petioles. *Medulla* entirely cellular, with numerous gum-canals. *Wood* consisting of a thin interrupted cylinder of striated tissue everywhere penetrated by medullary rays. *Fruits* borne on secondary axis, not protruding beyond the bases of the petioles.

Fragmentary specimens of this genus have been figured and described by Mantell as portions of the stem of *Bucklandia anomala*; and Corda has published drawings and descriptions of a fragment which should probably be referred here, under the name of *Zamites Bucklandi*. The only other published notice is contained in a short paragraph in the 'Proceedings' of this Society by Robert Brown. In 1851 he exhibited to the Society a series of specimens of recent and fossil *Cycadeæ*, among them one from the Isle of Wight, to which he gave the name *Cycadites Saxbyanus*. In the short abstract in the narrative of the 'Proceedings' (1851, p. 130), Mr. Brown is said to have pointed out that

[1] Quart. Journ. Geol. Soc. vol. xx. p. 77, pl. ix. f. 4.

"all the specimens of *Cycadites* hitherto found in the Isle of Wight agreed in having an elliptical outline, unaccompanied with any inequality in the woody ellipsis, and also in having a bud in the axilla of each leaf; in these respects differing from the *Cycadites* of the Isle of Portland, and from all the recent species of *Cycadeæ* with which we are acquainted, which have a circular outline and only scattered buds." Besides the specimens examined by Mr. Brown, I have obtained several additional examples of the same species, as well as specimens of other species, which have enabled me to make a more complete examination of their structure than the materials at his disposal permitted him to make. These reveal structures in the organs of fructification as well as in the stem, which require that they be separated into a distinct genus which cannot be classed under any of the recognized subdivisions of the Order, but is the type of another well-marked group of equal value with the others. To the genus I have given the name *Bennettites*, after my distinguished colleague, to whom, as my friend, instructor, and guide, I owe a debt I never can fully estimate.

In the remarkable external features noticed by Mr. Brown all the species agree. They have an elliptical axis and a bud in the axils of many, not of all, of the leaves. The stems are short. The oval medulla is composed of large subspherical cellular tissue, free from separate woody bundles, but penetrated everywhere with gum-canals. The pith is surrounded by a single cylinder of wood, the minute structure of which would be described as scalariform; but it is certainly different from the typical form of this found in living ferns, or in the arborescent *Lycopodiaceæ* of the Coal-measures. In transverse sections the wood-cells have the round or subquadrangular form of the fibres of living Cycads and Conifers. Longitudinally they exhibit transverse bars, or, rather, oval spaces; but when these markings are seen in section they are found to be external to the cell-wall, or, rather, equally related to the outside of the contiguous walls of two cells, as in the discigerous tissue of gymnosperms. This cannot be described as a transition from discigerous to scalariform tissue; but, indeed, from the nature of the two tissues (the one internal, the other external to the wood-cell), it is not possible that there can be any transition between them. The wood is abundantly penetrated by true medullary rays. The wood is composed of two layers, an outer and inner, looking, in transverse section, like the true wood and the accompanying "inner stratified cortical layer" of Link seen in recent trunks of this order; but in longitudinal section they are seen to be both prosenchymatous structures. Beyond the wood is a zone of cortical parenchyma similar in structure to the large medulla, and, like it, everywhere penetrated by gum-tubes. From this spring the leaves; the permanent bases of the petioles form an investing covering to the stem of considerable thickness. The vascular bundles which supply the leaves have their origin in the woody axis; but their relation to that axis is very different from that existing in other *Cycadeæ*. They rise, in all the known members of the Order, in the interior of the cylinder of wood, as bundles of small size, and, passing through the meshes of the ligneous cylinder, and then through the cortical parenchyma, as small distinct bundles, after running for a short distance, at least in some genera, in a horizontal direction parallel to the periphery of the stem, they pass into the petiole of each leaf. In this group of fossil Cycads the vascular tissue for each leaf springs from the woody cylinder in a single large

compact bundle, which as it passes outwards breaks up into the different bundles required for the service of the leaf. The woody portion of the stem is composed of a single layer, which, in transverse section, is seen to be repeatedly broken by the large meshes for the passage of the bundles (Plates LVII. fig. 3, LVIII. fig. 1, and LXII. fig. 2). The analogy between these fossil stems and the caudex of a tree fern is very remarkable. Indeed, excluding the nature of the component tissues of the stem, they differ only in that the fossil Cycad has medullary rays, and a cortical layer separating the vascular cylinder from the bases of the petioles.

The vascular bundle in *B. Saxbyanus* rises as a rounded swelling in the lower angle of the mesh on the inner surface of the woody cylinder (Plate LVII. fig. 5). A depression soon shows itself on the upper surface of the swelling, and the bundle extends upwards at the ends until, where it leaves the cylinder, it has a lunate transverse section (fig. 6). As it passes upwards and outwards through the cortical parenchyma the two ends are still more produced; then the arc which joined them below separates from them; afterwards the lower free ends curve inwards until they meet, forming a slightly interrupted oval figure with somewhat swollen sides (fig. 7). This finally breaks up into more than twenty separate small bundles, forming an upper and under series for the petiole (fig. 8). In *B. Gibsonianus* the vascular bundles pass directly outwards in an almost horizontal direction. The mass for each leaf separates from the woody cylinder as a whole, and has here the same form as in *B. Saxbyanus* (Plate LVIII. figs. 1–4); but it speedily breaks up into the numerous small bundles seen in the section of its leaf-stalk (fig. 3).

The petiole is rhomboidal or lozenge-shaped in transverse section, with the keel somewhat more pronounced than the angle on the upper surface. It is composed of large cells, somewhat elongated in longitudinal section (Plate LX. fig. 9), with numerous large gum-canals, and a double series of vascular bundles parallel to the surface, except below the upper angle, where they form a loop into the interior of the petiole. A very dense ramentum clothed the under surface of the base of the petiole, which was developed to such an extent as to separate very considerably each petiole from its neighbour. The petrifying material, having obtained speedy access to these delicate scales, has preserved them in a remarkably perfect condition. In some specimens, like that figured at Plate LVII. fig. 2, the petrified ramentum stands out as a network of ridges, while the originally more durable petioles have decayed and left rhomboidal cavities, representing their original form; but, in another specimen, the hard bases of the petioles have resisted the operation of the marine animal that burrowed in the ramentum, and they are left as prominences standing out from the body of the fossil (Plate LXII. fig. 1). The ramentum is composed generally of but a single series of cells; but sometimes it is two or more cells in thickness (Plate LX. fig. 11). The leaf disarticulated at a point some distance from the cortex, leaving a considerable portion of the bases of the petioles permanently surrounding the stem (Tab. LVII. fig. 1).

The axils of a large number of the petioles bore short branches. These axillary organs are important features in this group of fossil plants. In some fragmentary specimens, every axil is occupied by a bud, as described by Mr. Brown; but more frequently the majority of the leaves are without them. The proportion of the buds to the leaves

appears to be greater in the lower portions of the stem, and in stems belonging to old plants. These organs, however, are not properly buds; for although they do not appear to have pushed themselves beyond the permanent bases of the leaves, they are fully developed organs, and differ from the secondary axes of *Mantellia*, which are generally broken off beyond the surfaces of the permanent bases of the petioles, and show there a woody cylinder agreeing in structure with the principal axis of the plant.

The secondary axis consists of a very short and slender stem, bearing a number of simple linear acuminate leaves. These are the only foliar organs hitherto found connected with these fossils[1]. They are composed of oblong cells, all of which are marked with transverse bars, like scalariform tissue (Plate LX. figs. 8 & 10). Large gum-canals abound in them; and two vascular bundles run through the leaf, one on either side of its median line. The back of the leaf is sparsely clothed with membranaceous scales, like the ramentum on the petioles.

The branch terminates in a fleshy subpyriform enlargement, which bears the seeds. This is composed of, *first*, a cellular cushion; *second*, vascular cords supporting the seeds; and, *third*, a mass of irregular cellular tissue enveloping the whole.

The cushion (Plate LIX. fig. 3) is hemispherical in form, and is constricted at its base. It is composed of thin-walled, roundish cells (Plate LX. fig. 4), passing, at its upper portion, into oblong cells. Everywhere it is penetrated by small isolated vascular bundles composed of fine striated tissue (Plate LX. fig. 5), which rise up from the surface of the cushion. When free from the cushion, the cord (Plate LX. figs. 1 & 2) is composed first of the vascular axis, which is surrounded by a layer of very delicate cellular tissue, followed by a covering of larger and thicker-walled cells; and the cord is invested by a cellular membrane composed of a single cell in thickness. These vascular cords, with their accompanying cellular tissue, fill up the lower part of the fruit (Plate LX. figs. 1 & 2); as they decrease in size upwards the interspaces are filled in with the cellular tissue of the fleshy pericarp. The cords run into the base of the seeds. From the constriction at the base of the cellular cushion a cellular disk is given off, which is developed upwards, and envelopes all the organs that rise above it. It is covered externally with an epidermis formed of a double layer of equal-sized roundish cells (fig. 3). The inner layer frequently penetrates, by a fold, the parenchyma of the pericarp. This cellular disk, or fleshy pericarp, is composed of thick-walled, roundish cells. These are especially abundant in the upper portion, where the seeds are buried; but they also fill up the spaces between the vascular cords, and surround and invest the whole structure. The linear leaves of the branch surround the pericarp, and are closely adpressed to it. In all the specimens I have examined, the leaves are imbricated, and bent over on its upper surface.

The seeds are confined to the convex upper portion of the fleshy pericarp, being buried in deep pits, and forming a somewhat compact layer immediately under its surface. They

[1] I recently met with indications of a remarkable Cycadean leaf from the Lower Greensand, in the collection of fossils placed by Mr. Bensted in the Museum at Maidstone. Being of the same age as some species of *Bennettites*, it may belong to this genus. It is a very large leaf, with numerous long linear segments, attached very obliquely to the rachis. The segments are simple on the upper part of the frond; but the lower ones give off, at regular distances, several long and slender ultimate segments.

are small ovoid bodies, and are composed of two envelopes enclosing the albumen and embryo. The outer envelope, or testa, consists of a thin layer of delicate elongated cells; the inner is composed of a single series of oblong cells, arranged with the longest diameter at right angles to the walls (Plate LIX. figs. 6, 7, 8), and indurated by a considerable amount of secondary deposits. In the preparation (fig. 7), the seed is cut through at the chalaza, and the opening (through both envelopes), by which the vascular bundle entered is seen. On passing within the tegmen, the bundle expanded, forming a small cushion below the nucleus (fig. 7). The two coverings were produced upwards into a tubular exostome or styliform process, which, passing through the neck of the pit in which the seed is buried, was spread out like a stigma on the upper surface of the pericarp (fig. 6). The aspect of the whole fruit would closely resemble a reflexed receptacle of *Tambourissa* covered with innumerable stigmatic processes from the fruits buried in it, as figured by Baillon, 'Monogr. des Monimiacées,' p. 311. Enclosed by these envelopes is the nucleus, with its membranous covering, and abundant albumen. The subrectangular cells of the albumen are obvious in several specimens (fig. 9); but I have not hitherto detected the embryo. Its position may, perhaps, be indicated by a cavity which exists in some specimens in the upper part of the seed, and which was probably produced by the early decay and disappearance of the embryo. In some specimens an apparently confused arrangement of cellular tissue occupies this cavity (fig. 9); but I cannot detect in it the form of the embryo, though there can be no doubt that it really represents it. The albumen was solid behind the embryo, but was divided from top to bottom down its centre, in front of the embryo.

In comparing the structure of this plant with the inflorescence of the recent *Cycadeæ*, the points of difference are more obvious than those in which they agree. The most important correspondence is to be found in the structure of the seed and its envelopes. The fossil is truly gymnospermous, the pollen having access to the embryo-sac through the tubular openings in the covering of the seed, and not through a style developed from an investing carpellary organ. The most remarkable difference is to be found in the compound fruit of the fossil. In the recent members of the order, the fruit, whether borne on slightly modified leaves, as in *Cycas*, or on the peltate or imbricated scales of a cone, as in the other genera, is always produced on foliar organs. In the fossil, on the other hand, it is borne at the end of the axis. In this respect, however, it agrees with *Taxus*, except that it possesses innumerable seeds; it must be considered to hold the same relation to the other *Cycadeæ* that *Taxus*, with its succulent, cup-shaped pericarp, does to the cone-bearing *Coniferæ*.

Bennettites Saxbyanus, Carr. (Tab. LVII.)

1851. *Cycadites Saxbyanus*, R. Br. Proc. Linn. Soc. no. xlvi. p. 130.
1854. *Cycadeoidea Saxbyana*, Morris, Cat. Brit. Foss. p. 7.

Trunk elliptical, with large medulla, and thin, much-interrupted woody cylinder, vascular bundles passing upwards and outwards, and breaking up into two rows of small bundles, which are parallel to the superior and inferior surfaces of the petiole; section of petiole subtriangular.

From the Wealden beds at Brook Point, Isle of Wight. [British and Oxford Museums.]

I have examined three complete trunks of this species, and several fragments of other specimens. The longest specimen is the one in the Oxford Museum, which is 19 inches long. The smallest of the three trunks is very perfect; it is 7 inches high, its long diameter is 9 inches, and its short diameter $6\frac{1}{2}$ inches; 3 inches of this last measurement consists of the permanent bases of the petioles, $\frac{3}{4}$ inch of the cortical cellular layer, $\frac{1}{4}$ inch of wood, and $2\frac{1}{4}$ inches of medulla. The vascular bundle of each leaf rises upwards through the outer cellular tissue, passing the base of three or four leaves before it passes outwards to its own leaf. The leaf springs from the stem opposite to, though considerably above, the place where the vascular bundle left the woody cylinder. In a transverse section of this trunk, two or three series of vascular bundles are seen in the cortical layer. The petioles are separated from each other by a considerable layer of chaffy scales, which densely clothed their bases.

Corda, in his 'Beiträge zur Flora der Vorwelt' (tab. 17, p. 38), figures and describes the fragment of a fossil Cycad which he supposes came from England, and to which he gives the name of *Zamites Bucklandi*. It consists of a small portion of a stem from the woody axis to the surface, like rolled and broken fragments of both the Isle of Wight species which have been found on the shore at Brook. There are no indications, in the complete and evidently accurate drawings, of any secondary axes; but the form of the petiole, the arrangement of the vascular bundles, and the abundant ramentum between the petioles (which Corda considers to be intermediate or sterile scales), as well as the general form of the fragment, clearly show that it belongs to the genus *Bennettites*. Were it not that the petioles are in section so distinctly quadrangular and so small, I should not hesitate to refer it to this species. It may, however, represent a distinct species, with a smaller stem than the others; but this cannot be determined without additional materials.

Cycadites Schachtii, Coem., a stem from the remarkable deposit of coniferous remains of Upper Cretaceous age, found at Hainault, in Belgium, probably belongs also to this genus. M. Coemans has not observed any axillary branches; but his admirable drawing exhibits the large meshes in the woody cylinder characteristic of this group of fossils.

B. MAXIMUS, sp. nov.

Trunk large, oval; medulla large; woody cylinder very thin and repeatedly broken; cortical layer large, everywhere penetrated by the ascending lunate vascular bundles, which are small and very numerous; sections of petiole triangular, with the lateral angles produced and very acute; ramentum very abundant and separating widely the bases of the leaves.

This species is very near to *B. Saxbyanus*; but it can easily be distinguished by its greater size, and by the very slender woody cylinder.

From the Lower Greensand at Shanklin, Isle of Wight. [Museum of Practical Geology, Jermyn Street.]

B. Gibsonianus, sp. nov. (Tab. LVIII.–LX.)

Trunk compressed elliptical, with small medulla, and a thick subcontinuous woody cylinder; vascular bundles passing almost directly outwards and breaking up into a double series of small bundles, which are parallel to the superior and inferior surfaces of the petiole, except that a loop is sent down from the upper series into the centre of the petiole. The section of the petiole is subquadrangular.

Water-worn fragments of this species and of *B. Saxbyanus* have been mistaken for portions of *Bucklandia anomala*. Mantell, in his 'Medals of Creation,' vol. i. p. 163, fig. 57, gives a very good woodcut of one of these fragments, which he has reproduced in several of his publications.

The trunk in the most complete specimen which I have seen is 8 inches long, but it is imperfect at both ends. Mr. Gibson informs me that it was a third longer when he found it. The long diameter is 11 inches, and the short $6\frac{1}{2}$ inches; of this the medulla forms 1 inch, the wood $1\frac{1}{2}$ inch, and the bases of the petioles 4 inches—the outer, cortical layer being very thin.

The specimen is beautifully preserved. From it I have determined the structure of the genus and the nature of the reproductive organs, as explained under the genus.

The secondary axes have from thirty to forty thick linear leaves arranged in several whorls. In form these leaves agree with those subtending the carpophylls in *Cycas circinalis*; and their functions were the same: they protected the organs of reproduction. They are closely applied to the fleshy receptacle, and are bent over and imbricated on the upper surface. The pollen may have obtained access to the ovules in the same way as Mr. Yates has noticed it is admitted to the ovules of the living species named. He has observed the compact bud, consisting of the carpophylls surrounded and closely protected by the scales, open up and remain spread out for some time—about three days—then firmly close, and remain so until the seeds had considerably advanced.

From the Lower Greensand at Luccomb Chine, Isle of Wight, *Thomas F. Gibson, Esq.* [British Museum.]

B. Portlandicus, sp. nov. (Tab. LXI.)

Trunk elliptical, with small medulla, a thin interrupted woody cylinder, and large cortical cellular layer, through which the vascular bundles pass out in a slightly ascending direction to the bases of the petioles; the section of the petiole subrhomboidal or triangular, with the lower angle very obtuse, the lateral angles acute and produced, and the superior base-line of the triangle slightly bent outwards.

From the Dirt-bed in the Isle of Portland. [Museum of the Geological Society.]

B. Peachianus, sp. nov. (Tab. LXII.)

Trunk elliptical, very compressed, with a large elliptical medulla, having the narrow ends somewhat produced; woody cylinder subcontinuous, slightly interrupted at intervals by the narrow mesh connected with the vascular bundles; vascular bundles passing directly outwards; petioles in section compressed quadrangular.

The specimen is 10 inches long, but it is imperfect at both ends. The long diameter is 17 inches, and the short 7 inches; of this $4\frac{1}{4}$ inches are medulla, $1\frac{1}{4}$ inch wood, and $1\frac{1}{2}$ bases of leaves, which, however, are a good deal abraded. Scattered secondary axes occur among the petioles. The only specimen of this magnificent Cycad hitherto found is not very perfectly preserved; but there is more than sufficient to show that it belongs to this genus, and is very different from the other species.

From the Oolite strata of Helmsdale, Sutherlandshire, *C. W. Peach, Esq.* [British Museum.]

VII. Mantellia, Brongniart.

1828. *Mantellia,* Brongn. Prodrome, p. 96.
1828. *Cycadeoidea,* Buckl. Proc. Geol. Soc. p. 80; (1829) Trans. Geol. Soc. ser. 2. vol. ii. p. 395.
1836. *Cycadites,* Buckl. Geol. & Miner. p. 496.
1849. *Echinostipes,* Pomel, Amtlicher Bericht Aachen, 1847, p. 346.

Trunk cylindrical, covered with the long permanent bases of the petioles. *Medulla* entirely cellular, with numerous gum-canals. *Wood* consisting of a cylinder of striated tissue everwhere penetrated with medullary rays. *Fruits* borne on secondary axes, generally protruding beyond the bases of the petioles.

The names *Mantellia* and *Cycadeoidea* were published almost simultaneously and independently. The earliest date I can discover for *Cycadeoidea* is the abstract of Buckland's paper, published in the Philosophical Magazine for September 1828. The authoritative abstract of the Geological Society has no date upon it. The name was adopted by Buckland on the suggestion of R. Brown, who proposed it as an ordinal and not as a generic name. The paper was published in full, with four plates, in the Transactions of the Society, in 1829. On the first opportunity thereafter, in his Bridgewater Treatise, Buckland, at R. Brown's suggestion, withdrew his "provisional name," and adopted that of *Cycadites*, setting aside Brongniart's *Mantellia*, because it had already been employed by Parkinson for a genus of sponges. This genus, however, has been rejected by subsequent writers, as it joins together species which have no affinity, by characters that are merely accidental (Toulmin Smith). *Mantellia* was proposed in the early, systematic portion of the 'Prodrome.' In the passage of his work through the press, Brongniart heard of Buckland's Memoir, and referred to it in a note to the later, stratigraphical portion (p. 199). He objects to the name *Cycadeoidea*, and retains in the text the name he proposed in the earlier part of the volume. Were Buckland's name unobjectionable, it ought to be retained, because of its priority by a month or two; but as it originated in an error, was withdrawn by its author, and is in itself, as Brongniart and others have stated, objectionable, it seems necessary to reject it in favour of *Mantellia*.

The remarkable stems of this genus have been fully investigated in the important memoir of Buckland, which owes much of its value to the assistance given to the author in his work by R. Brown. The fossils differ from *Bennettites* in their form, as well as in the more distinctly rhomboidal petioles and the elongated secondary axis. They agree in the nature of the tissues and the method in which they are built up in the stem. The petioles are clothed with a dense ramentum, and they have numerous axillary branches which bore small, simple, linear-lanceolate leaves. The branches, when full-grown, are broken off at the point where they leave the bases of the petioles. Sometimes they are

undeveloped, and still exist as unexpanded leaf-buds, terminating the shortened branch. These buds are composed of leaves, protected by a very dense and very abundant ramentum. The branches precisely agree with those in *Bennettites*, and have been, I have no doubt, like them, the supports of the organs of reproduction; only the fruits, having been borne at the ends of elongated and consequently unprotected branches, have been broken off.

Some stems have no lateral buds. These may have been male plants; and their staminal flowers were perhaps cones, produced at the termination of the main axis.

While the bulbils observed in some living *Cycadeæ* enable us to understand the occurrence of axillary appendages in the fossils, it must be remembered that the branches of *Bennettiteæ* are very different from them. These branches had a well-developed and regularly arranged woody system, and were permanent organs of the plant, being thus as different structurally as they were functionally from the deciduous bulbils of existing Cycads.

The trunks of *Mantellia* have been described as spheroidal. They were really cylindrical, and may have attained a considerable height. Their flattened condition arises from the pressure of the superincumbent mass of rock on the earth or "dirt" bed in which they are preserved.

MANTELLIA NIDIFORMIS, Brongn. Prodr. pp. 96 and 199 (1828). (Tab. LXIII. fig. 1.)

1828. *Cycadeoidea megalophylla*, Buckland, Proc. Geol. Soc. vol. i. p. 80; (1829) Trans. Geol. Soc. ser. 2. vol. ii. p. 397, pls. 47, 48.
1834. *Mantellia megalophylla*, Bronn, Lethæa Geogn. vol. i. p. 227.
1836. *Cycadites megalophyllus*, Buckl. Geol. & Mineral. p. 496, plate lx.
1838. *Zamites megalophyllus*, Presl, Sternberg's Flora der Vorwelt, p. 196.
1842. *Encephalartos Bucklandii*, Miquel, Monogr. Cycad. p. 60.
1849. *Echinostipes nidiformis*, Pomel, Amtlicher Bericht Aachen (1847), p. 346.

Trunk cylindrical, permanent bases of the petioles large, lozenge-shaped, two to three inches broad, by one and a half deep, meshes in the woody cylinder small and scattered.

This is the largest species of the genus. It is generally found very much compressed and pressed out, showing a greater diameter and much less height than belonged to it. The apex of the stem being more perishable and longer exposed to the action of those changes which covered the Coniferous and Cycadean forest with a great thickness of sandstone, has disappeared, leaving a hollow in the flattened stem; and this has suggested to the quarry-men the notion, universally entertained by them, that they are crows' nests.

Axillary branches are not so frequent in this species as in the others. Among the many stems which I have examined, I have seen only a small number with a few of them.

From the "Dirt-bed" in the Isle of Portland. [British, Jermyn-St., Geological-Soc., and other Museums.]

M. INTERMEDIA, sp. nov. (Tab. LXIII. fig. 4 et 5.)

Trunk cylindrical; permanent bases of the petioles large, lozenge-shaped, an inch and a

half to an inch and three-quarters broad by three-quarters of an inch deep; meshes of the woody cylinder large, roundish, and frequent.

The smaller, equal-sized petioles and the more slender trunk at once distinguish this species from *M. nidiformis*. I have seen only two specimens, and neither of them show any indications of secondary axes.

From the "Dirt-bed" in the Isle of Portland. [British Museum.]

M. MICROPHYLLA, Miq. Prodr. Syst. Cycad. p. 30. (Tab. LXIII. fig. 6.)

1828. *Cycadeoidea microphyllus*, Buckl. Proc. Geol. Soc. vol. i. p. 80; (1829) Trans. Geol. Soc. ser. ii. vol. ii. p. 397, t. 49.
1836. *Cycadites microphyllus*, Buckl. Geol. & Miner. p. 426, pl. 61.
1838. *Zamites microphyllus*, Presl, in Sternberg, Flora der Vorwelt, p. 196.
1849. *Echinostipes microphyllus*, Pomel, Amtl. Bericht Aachen, 1847, p. 346.

Trunk cylindrical; permanent bases of the petioles small, lozenge-shaped, an inch broad by three-eighths of an inch deep; meshes in the woody circle numerous and small.

This is the most abundant species in the "Dirt-bed" of the Isle of Portland. Axillary branches abound in the stems. The description I have given of the branches in this genus is taken from specimens of this species.

From the "Dirt-bed" in the Isle of Portland. [British, Jermyn-Street, Geological-Society, and other Museums.]

M. PYGMÆA, Carr.

1837. *Cycadeoidea pygmæa*, Lindl. & Hutt. pl. 143.
1841. *Zamites pygmæus*, Morris, Ann. Mag. Nat. Hist. vol. vii. p. 116.
1849. *Echinostipes pygmæus*, Pomel, Amtl. Bericht Aachen, 1847, p. 347.

Trunk small, subspherical; bases of the petioles irregularly lozenge-shaped, three-eighths of an inch broad by one-eighth deep, widely separated by ramentum.

A single specimen of this species has been found. It was cut longitudinally, and showed that it was composed of the bases of the petioles placed perpendicularly on a thick and solid centre. It is described as having a tubercle or rudimentary branch. I have not been able to discover where this curious specimen is preserved; it belonged to Miss Philpotts at the time it was figured by Lindley and Hutton.

From the Lias of Lyme Regis.

M. INCLUSA, sp. nov. (Tab. LXIII. fig. 2 et 3.)

Trunk small, cylindrical; medulla abundant; wood-cylinder slender; cortical layer large, penetrated by numerous small, ascending, vascular bundles; bases of the petioles regularly lozenge-shaped, three-eighths of an inch broad by a little more than an eighth deep; secondary branches large; fruit included in the bases of the petioles.

This species has the cylindrical stem of *Mantellia* with the included fruits of *Bennettites*.

From the Potton Sands, Cambridgeshire. [In the Collection of Wm. Reed, Esq., F.G.S., York.]

VIII. Raumeria, Göppert.

1844. *Raumeria,* Göpp. Wimmer's Flora von Schlesien, vol. ii. p. 217; (1853) Denkschrift zur Feier von der Schles. Gesellsch. p. 259.

Trunk cylindrical, densely covered with the bases of the fronds and with stipulæform scales. *Scars* of the petioles subrhomboidal, arranged quincuncially, and separated by the rhomboidal scars of the scales or stipules.

This genus is based upon the fragments of two stems, which I should not hesitate to refer to *Mantellia*, were it not for the small stipulæform scars which are placed in quincuncial spirals among the large petiolar scars. They have the same form as the petiolar scars, and are made up of whitish parenchyma penetrated by gum-canals. The vascular tissue has disappeared. In the possession of these small scars they differ, as Göppert observes, from all known Cycads, recent or fossil. Both species have axillary branches, composed of small leaves grouped in a circular elliptical manner, and which are in section similar to the stipulæform scars. The large scars figured in *R. Reichenbachiana* are formed by the decay of the axillary organ, which probably had the fruit buried in the bases of the petioles. Similar appearances may be seen in the drawing of *Mantellia inclusa*, in Plate LXIII. fig. 3, and in several specimens of *Bennettites*, in the collections of the British Museum and Geological Society.

Göppert establishes a new tribe of *Cycadeæ*, under the name *Filicoideæ*, for these two fossils, because of the separation of the petiolar cicatrices by the small interposed scars reminding him of the stems of ferns. There can be little doubt that they are near allies of the forms I have included in *Bennettiteæ*. The discovery of more perfect specimens would enable us to understand the structure of their fruits and the nature of the stipulæform appendages. The hope of this, however, is very small, as neither of the specimens was found *in situ*, and their age is consequently unknown; the one was found in the earth thrown out of a canal near Gleiwitz, and the other in a swamp near Wieliczka.

R. Schultziana, Göpp. Wimmer's Flora, vol. ii. p. 217; Denkschrift, p. 259, tab. vii. figs. 1–5, tab. viii. figs. 1–3.

Cicatrices of the petioles transversely subrhomboidal, six lines broad and three to four lines deep, lateral angles acute, superior and inferior obtuse; scars of the stipulæform scales subtrigonous, from two to two and a half lines broad, arranged quincuncially among the larger scars.

Found in the Klodnitz canal, near Gleiwitz.

R. Reichenbachiana, Göpp. Wimmer's Flora, vol. ii. p. 217; Denkschrift, p. 262, tab. viii. figs. 4–7, tab. ix.

Cicatrices of the petioles trigonous, six to eight lines broad and six lines deep, angles obtuse; scars of the stipulæform scales small, subtrigonous, from one to one and a half line broad, arranged quincuncially among the large scars.

Found in a swamp at Lednice, near Wieliczka, in 1753.

EXPLANATION OF THE PLATES.

All the figures half the size of nature, except when a portion is represented natural size for some special purpose, or is greatly magnified, as in the case of microscopic sections. The proportion of each figure to the original is in every case stated on the Plate.

Plate LIV.

Fig. 1. *Bucklandia anomala*, Presl, from a specimen, found at Ausly near Cuckfield, in the Geological-Survey Museum, Jermyn Street.

Fig. 2. Fragment of the same species, showing the triradiate scar sometimes shown on the cicatrix, from a specimen from Cuckfield, in the British Museum.

Fig. 3. Stem of the same species, showing the indurated mucilage in the interspaces of the leaves on the upper part, and forming large drops in the lower half. The cast of the woody cylinder is seen projecting from the lower part of the upper portion. From a specimen from Cuckfield, in the British Museum.

Fig. 4. *B. Mantellii*, Carr., showing the scars of two series of spadices, scales, and true leaves, from a specimen from Cuckfield, in the British Museum.

Fig. 5. Seeds of *Bucklandia* from Cuckfield, in the British Museum.

Fig. 6. Antheriferous cone of *Bucklandia* (?) found by S. R. Pattison, Esq., at Hastings, in the British Museum.

Plate LV.

Fig. 1. *B. Milleriana*, Carr., from a specimen found at Brora by the Rev. J. M. Joass, in the Museum at Dunrobin Castle.

Fig. 2. *Yatesia gracilis*, Carr., from a specimen from Lyme Regis, in the British Museum.

Fig. 3. *Y. Morrisii*, Carr. Showing the bases of the petioles, the thin layer of bark, and the cylinder of wood, from a specimen from Potton, in the Museum of the Royal Agricultural College, Cirencester.

Fig. 4. A few scars of the same species; and

Figs. 5 & 6. Fragments showing the double cylinder of wood, the thin bark, and the bases of the petioles, from specimens from Potton, presented by Prof. T. Rupert Jones to the British Museum.

Fig. 7. *Y. crassa*, Carr., from a specimen from Brora, in the Museum at Dunrobin Castle.

Fig. 8. *Y. Joassiana*, Carr. Showing the ring of bract-scars, and the cicatrix of a peduncle, from a specimen in Dunrobin-Castle Museum, found by the Rev. J. M. Joass at Brora.

Fig. 9. The other side of the same specimen, showing the markings of the wood-cylinder, and the scar where the dichotomously divided half of the stem has been broken off.

Plate LVI.

Fig. 1. *Fittonia squamata*, Carr., from a specimen found in the Isle of Wight, by Captain Ibbetson, in the Museum of Practical Geology, Jermyn Street.

Fig. 2. View of the base of the same specimen.

Figs. 3 & 4. Bases of two petioles, showing the number and arrangement of the vascular bundles.

Fig. 5. Section of the persistent base of a petiole, showing its form; the angle is more acute than it was in the living plant, from the pressure to which the specimen has been subjected.

Fig. 6. Section of several petioles on the edge of the specimen, greatly compressed.

Plate LVII.

Fig. 1. Longitudinal section of *Bennettites Saxbyanus*, Carr., showing the pith, wood cylinder, bark, bases of the leaves, and one fruit-cavity, from a specimen from Brook Point, in the British Museum.

Fig. 2. The external appearance of the broad surface of the same specimen. The bases of the petioles form cavities, the network of ridges being composed of the dense ramentum. A cavity formed by a fruit is seen near the centre of the specimen.

Fig. 3. Transverse section of *B. Saxbyanus*, Carr., showing the pith, the woody cylinder broken by the meshes through which the vascular bundles to the petioles pass, the pith everywhere penetrated by the vascular bundles, and the rubbed bases of the petioles : from a specimen from Brook Point, in the British Museum.

Fig. 4. Fragment of the same species, showing on the fractured surface the direction of the vascular bundles from the wood through the pith to the petioles.

Fig. 5. The origin of the vascular bundle at the base of the mesh on the inner surface of the woody cylinder.

Fig. 6. The form of the bundle as it leaves the woody cylinder.

Fig. 7. The bundle as it passes through the bark.

Fig. 8. The bundle broken up into smaller bundles in the petiole itself.

Plate LVIII.

Fig. 1. Transverse section of *B. Gibsonianus*, Carr., showing the pith, wood, bark, and bases of the leaves, with a longitudinal section of a fruiting branch. Sections of gum-canals are seen in the petioles : from a specimen found by T. F. Gibson, Esq., at Luccomb Chine, in the British Museum.

Fig. 2. Longitudinal section of the same, perpendicular to the line forming the base of fig. 1. The transverse sections of the petioles are seen, with the number and arrangement of the vascular bundles. Four fruit-bearing branches are cut through. The upper central one is cut through the cushion which terminates the branch, and shows the whorls of leaves surrounding it. That in the centre of the figure is cut through the vascular cords ; while those on the right and left of the specimen are cut through the upper cellular and seed-bearing portion of the fruit.

Fig. 3. A portion of the last section, the size of nature, containing two of the fruit-bearing branches.

Fig. 4. A portion of fig. 1, showing the wood cylinder and two vascular bundles pairing off to the petioles.

Fig. 5. The portion of fig. 1 showing the longitudinal section of the fruit, the size of nature. The leaves at the side of the fruit are in longitudinal section, and those at the apex in transverse, being imbricated over the fruit.

Plate LIX. Fruits of *B. Gibsonianus*, Carr.

Figs. 1 & 2. Longitudinal and somewhat oblique sections towards the side of the fruit. The investing leaves are seen in transverse section at the base. The dark space within the leaves represents the fleshy substance of the fruit, which is largely developed above, but is also a very distinct structure along the sides and at the base of the fruit.

Fig. 3. Longitudinal section through the centre of the fruit, showing the cellular cushion and the other parts of the structure.

Figs. 4 & 5. Transverse sections, the first near the apex and the second towards the middle of the fruits.

Fig. 6. Section of a young seed, showing its coverings prolonged into a styliform tubular process, penetrating the fleshy pericarp, and spreading on its surface as a dilated stigma-like disk. One of the adpressed leaves is seen in transverse section, covering this disk.

Fig. 7. Section of a seed, showing the two layers of the coat, and the opening at the base for the entrance of the vascular cord, which spreads out immediately on entering the seed.

Fig. 8. Section of a seed, showing the two layers of the coat, and the delicate membrane investing the nucleus (nucleus residuum membraniforme, *Miquel*). In the same figure there is a section through the walls of the coat, showing the polygonal form of the cells of the inner indurated wall, and the elongated thin cells of the outer wall.

Fig. 9. Section of a seed, showing the form of the cells of the albumen, and the position of the embryo.

Plate LX.

Figs. 1 & 2. Transverse and oblique sections of the vascular cords, showing the small bundle of scalariform tissue in the centre, surrounded by, first, a layer of small delicate parenchyma which has generally disappeared, and, second, the thicker-walled and larger parenchyma of the bundle, the whole being covered by a membrane composed of a single series of small cells. All the cells of the cord are elongated, with blunt ends. The space between the cords is composed of small spherical cells, which increase in size towards the apex of the fruit.

Fig. 3. The parenchyma from the side of the fruit, with its epidermis, composed of a double layer of cells, the inner one being sometimes folded into the substance of the fruit.

Fig. 4. A portion of the cushion, showing one bundle of scalariform tissue passing through it, and the origin of the tissues connected with the cords.

Fig. 5. The bundle of scalariform tissue seen in fig. 4, greatly magnified.

Fig. 6. Transverse section of a leaf from the base of the fruit figured on Plate LIX. fig. 1.

Fig. 7. Transverse section of a petiole, showing the arrangement of the vascular bundles, and the dense ramentum.

Fig. 8. Longitudinal section of a leaf from the margin of the fruit figured on Plate LIX. fig. 1, showing the form of the cells and a large gum-canal.

Fig. 9. Longitudinal section of a petiole with numerous gum-canals.

Fig. 10. A cell from the leaf, fig. 8, greatly magnified, to show the scalariform markings on its walls.

Fig. 11. Transverse section of the ramentum from the lower surface of the petiole.

Fig. 12. Scalariform tissue of *Bennettites Gibsonianus*, Carr.

Fig. 13. Disk-bearing tissue of *Yatesia Morrisii*, Carr.

Plate LXI. *Bennettites portlandicus*, Carr.

Fig. 1. External aspect of the fossil: from a specimen in the Museum of the Geological Society of London.

Fig. 2. Transverse section, showing the pith, the slender wood cylinder, and the bark, with the permanent bases of the petioles.

Fig. 3. A portion of the fossil, showing several petioles and two fruit-branches, natural size.

Fig. 4. A portion of the cavity in the base of the specimen representing the wood cylinder.

Fig. 5. A fruit-bearing branch, with the petiole in whose axil it was borne, the size of nature.

Plate LXII.

Fig. 1. External aspect of *B. Peachianus*, Carr., from a specimen found on the beach at Helmsdale, by C. W. Peach, Esq., now in the British Museum. The specimen has been attacked by species of *Pholas*, and by *Leucodore ciliatus*, Johnst. The bases of the petioles have resisted the action of this little annelid, which has everywhere attacked the interspaces originally filled by the ramentum. A few small fruit-bearing branches occur scattered over the surface of the specimen. It should be stated that the surface towards the name in the plate is the upper portion of the stem.

Fig. 2. Transverse section of the same specimen, showing the pith, the wood cylinder, the bark, and the bases of the petioles.

Plate LXIII.

Fig. 1. Cylindrical specimen of *Mantellia nidiformis*, Brongn. From a specimen from the Isle of Portland, in the British Museum. In the upper portion of the specimen the wood cylinder is shown, and the large meshes in it through which the vascular bundles passed.

Fig. 2. The upper surface of *M. inclusa*, Carr., showing the pith, the size and position of the wood cylinder, which has perished, the pith everywhere penetrated by the ascending vascular bundles belonging to the petioles, and the petioles. The specimen was found at Potton, Cambridgeshire, and is in the collection of W. Reed, Esq., F.G.S., York.

Fig. 3. Outer surface of the same specimen, showing several cavities where fruiting branches were borne.

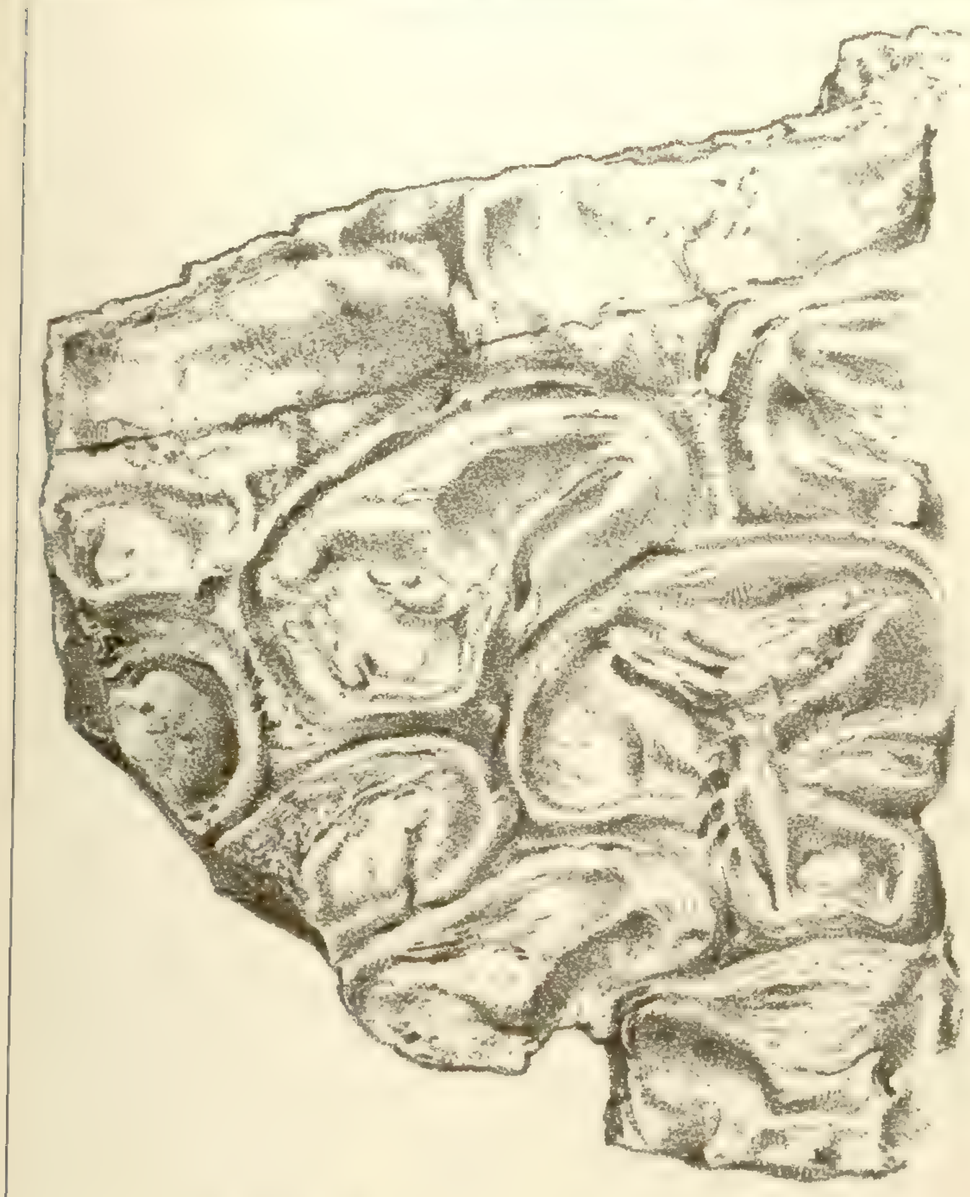
Fig. 4. Several petioles of *M. intermedia*, Carr., from a specimen from the Isle of Portland, in the British Museum.

Fig. 5. Portion of the wood cylinder of the same species, showing the number and size of the meshes. From a specimen from the Isle of Portland, in the British Museum.

Fig. 6. Several petioles of *M. microphylla*, Miq., from a specimen from the Isle of Portland, in the British Museum.

POSTSCRIPT.

Through the kindness of Principal Dawson I have seen a photograph of one of the Cycadean stems found by P. Tyson, Esq., in Maryland, referred to on p. 679. The specimen from which it was taken was fifteen inches in height. It is obviously a species of *Bennettites*, with smaller leaf-scars than those in *B. Saxbyanus*. Numerous axillary branches are seen, some of which are hollow in the centre from the fruits having perished. Dr. Dawson informs me that Mr. Tyson regards the beds in which he obtained the specimens as most probably of Wealden age.



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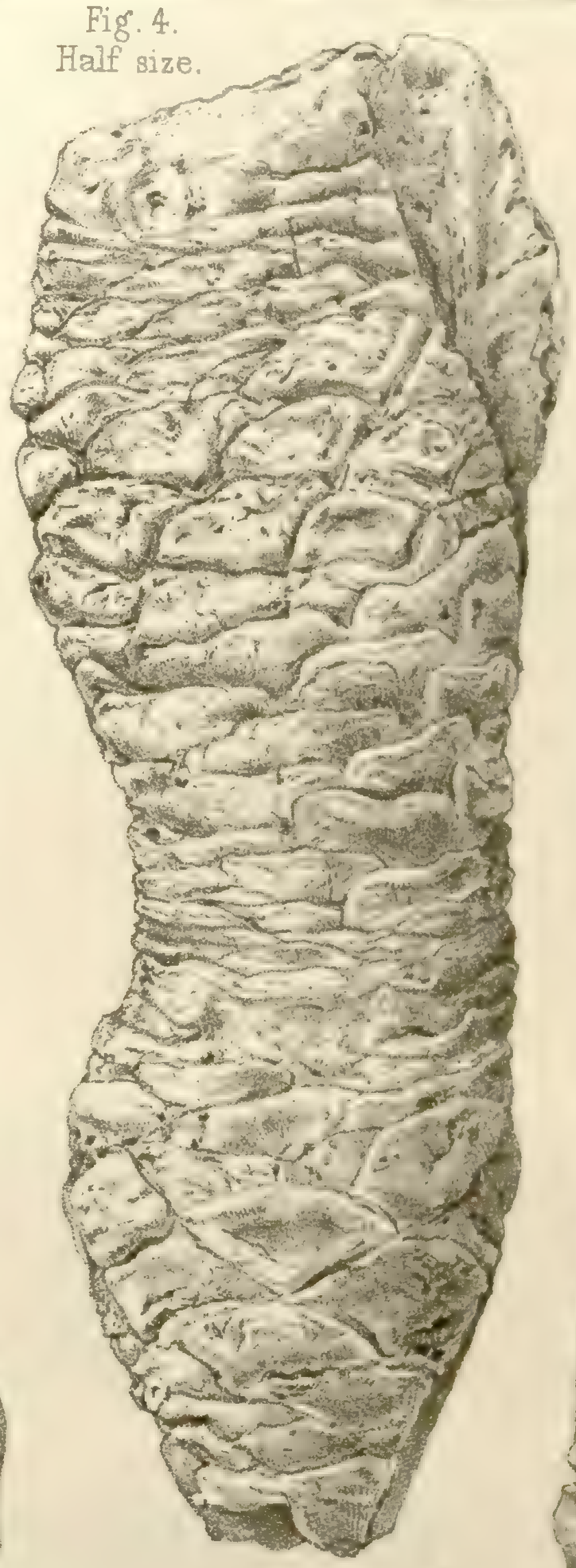

Fig. 4.
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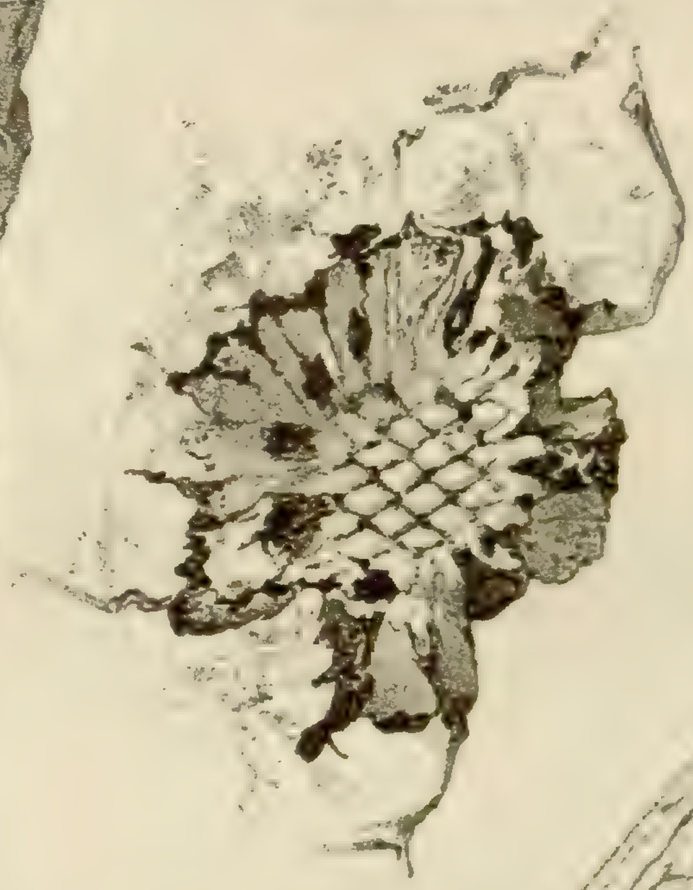

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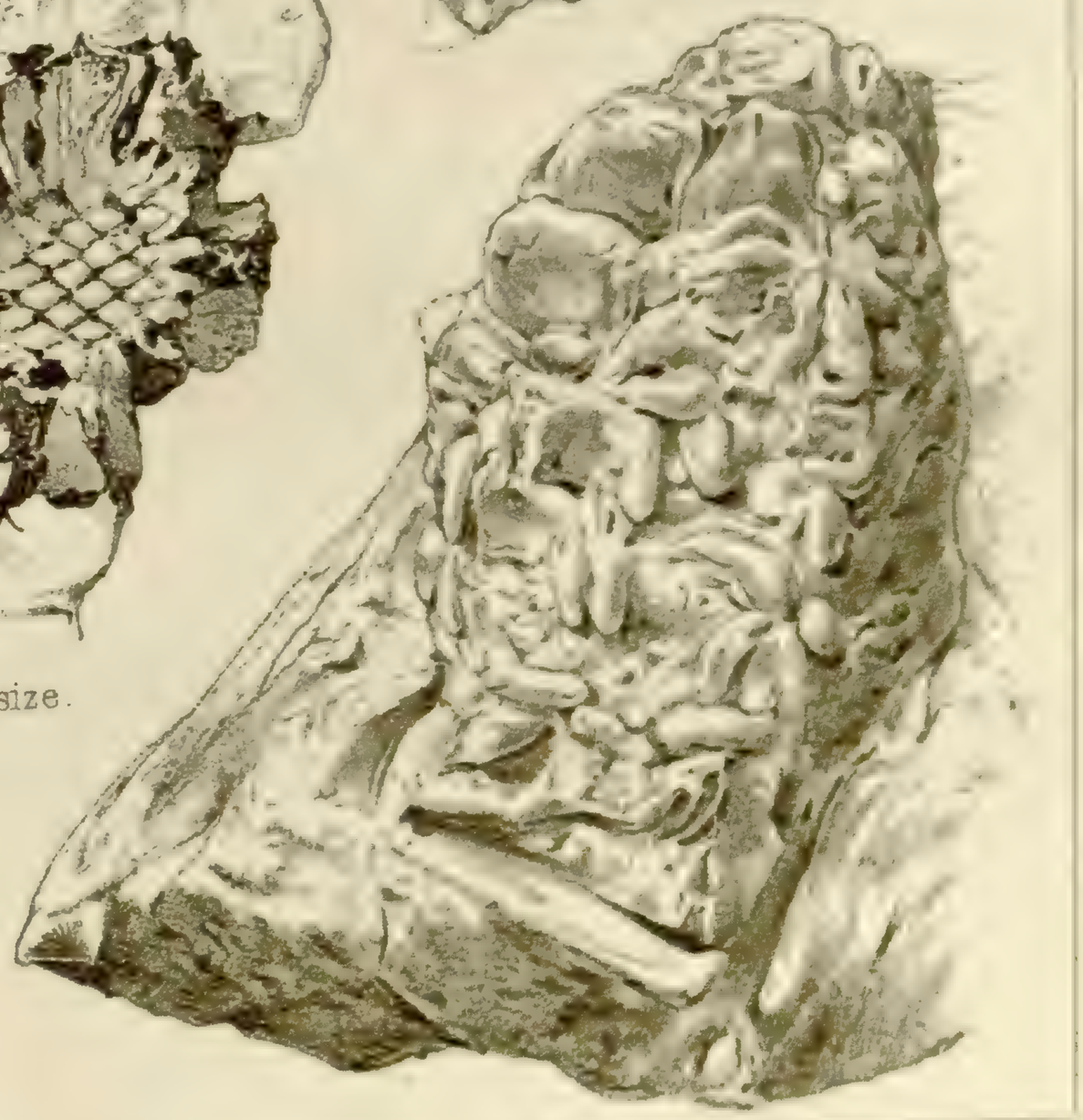


Fig. 1. Half size.

W. G. Smith, ad nat. lith.

1. 2, 5, Bucklandia anomala. 4. B. Mantellii. 5. Seeds and 6. Antheriferous cone of Bucklandia

Fig. 1. Half size.

Fig. 2. Half size.

Fig. 3. Half size.

Fig. 4. Half size.

Fig. 5 Half size

Fig. 6 Half size

Fig. 7. Half size.

Fig 8 Half size

Fig. 9 Half size

W. G. Smith ad nat lith.

1. Bucklandia Milleriana. 2. Yatesia gracilis. 3-6 Y. Morrisii. 7 Yatesia 8,9 Yatesiana

Fig. 1. Half size.

Fig. 3 Nat size

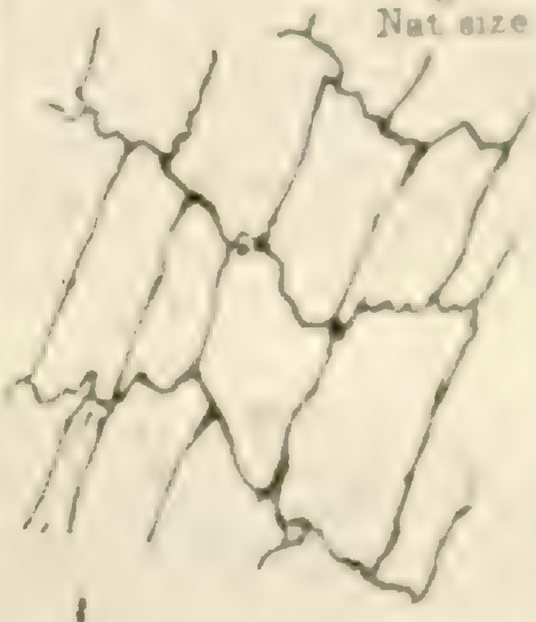


Fig. 4 Nat size

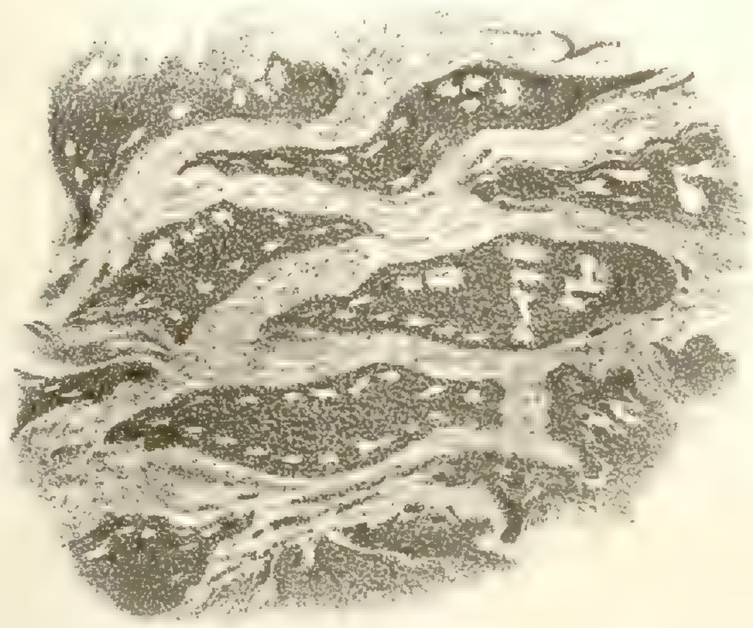
Fig. 5. Nat size.

Fig. 2 Half size

W. G. Smith, ad nat lith.

Fittonia squamata

Fig. 8. Nat size



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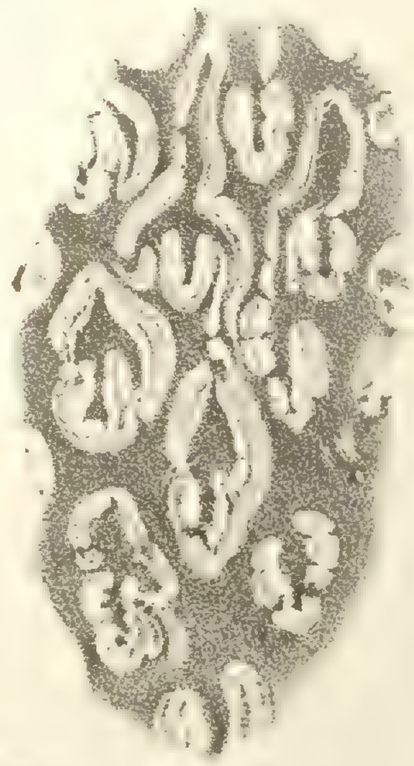

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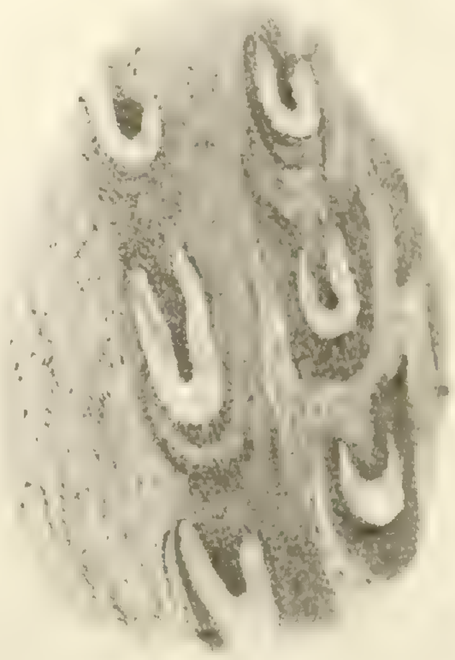

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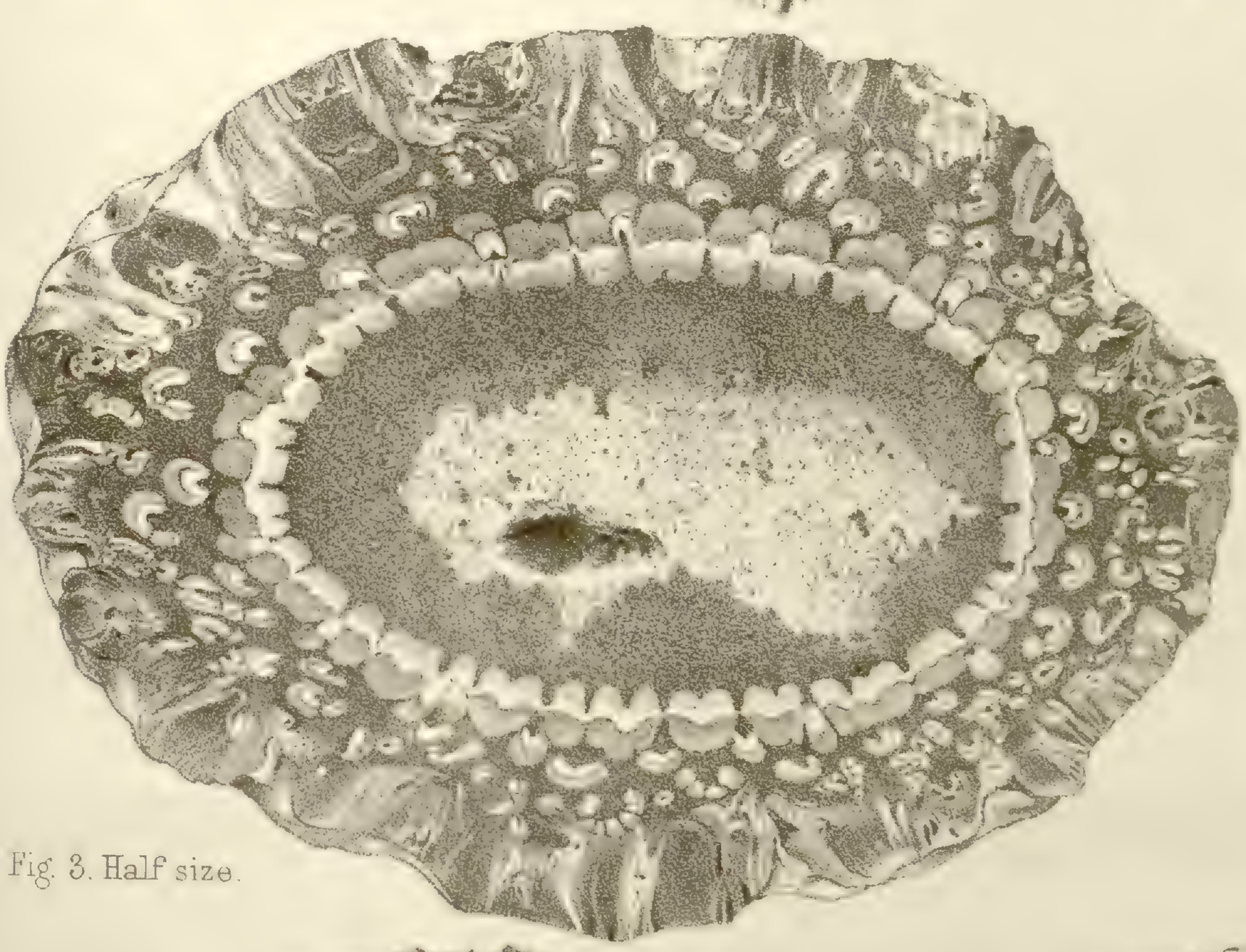

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Fig. 4 Half size

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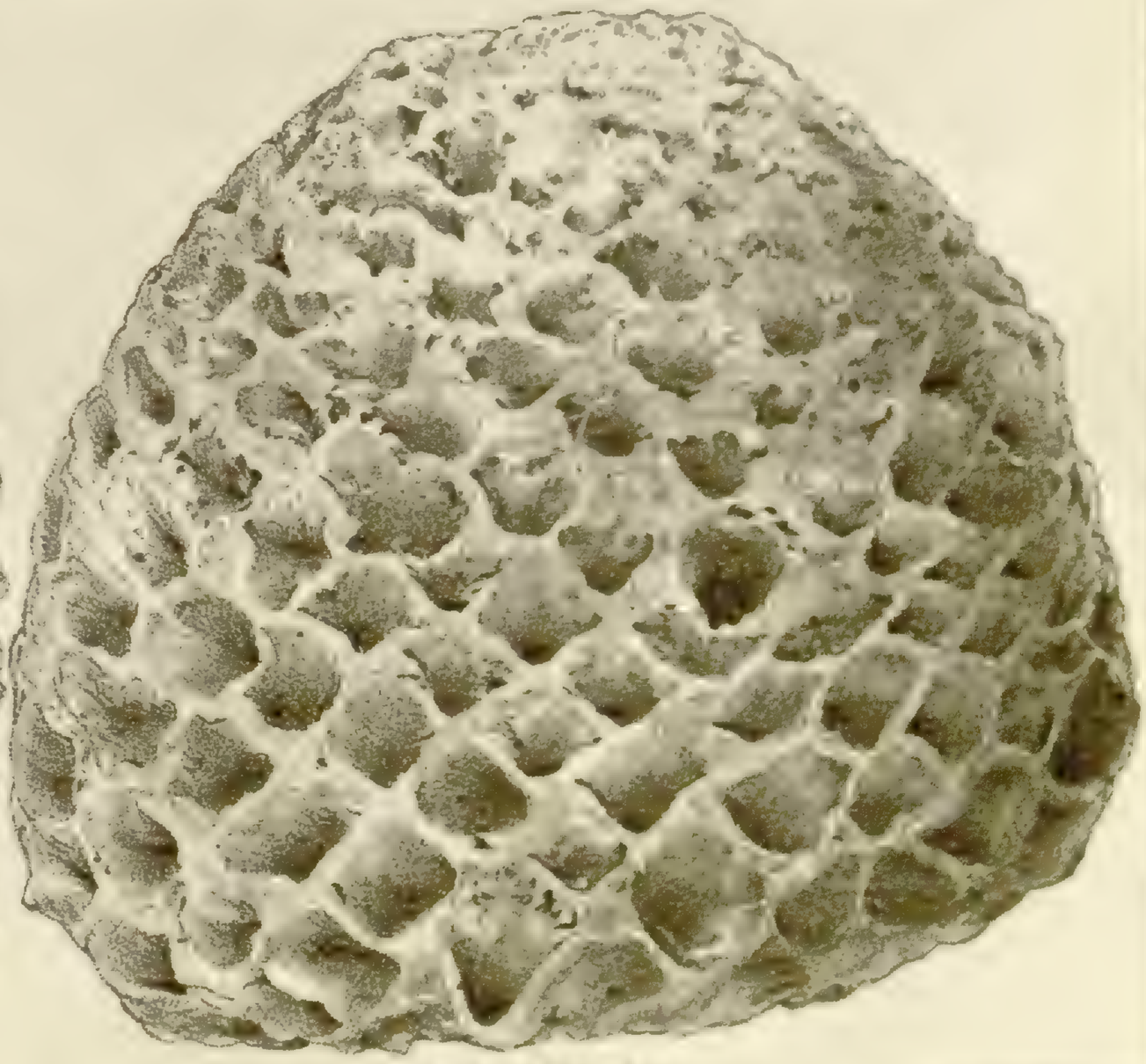
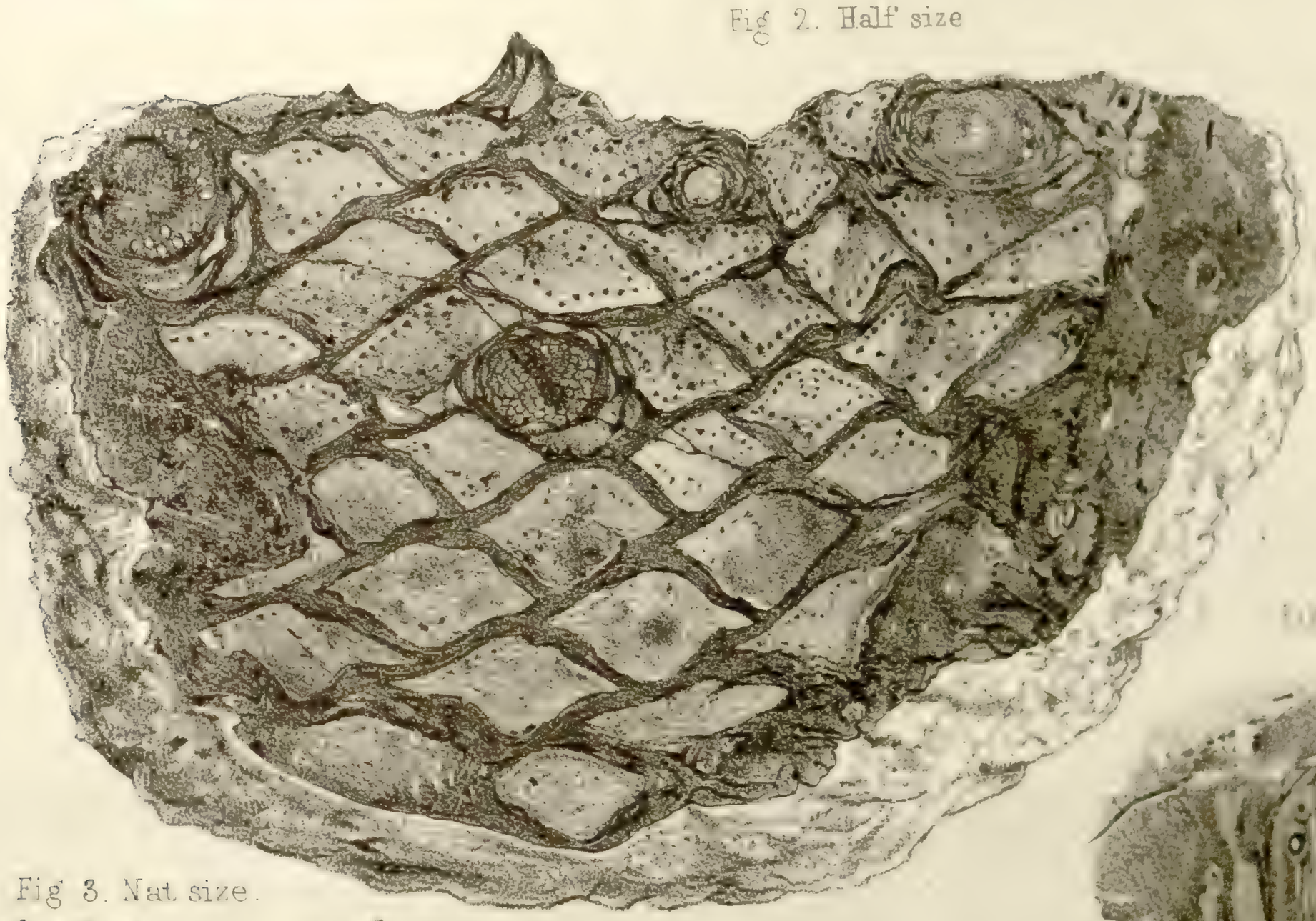


Fig 2. Half size

W G Smith ad nat lith

Bennettites Saxbyanus

Fig 2. Half size



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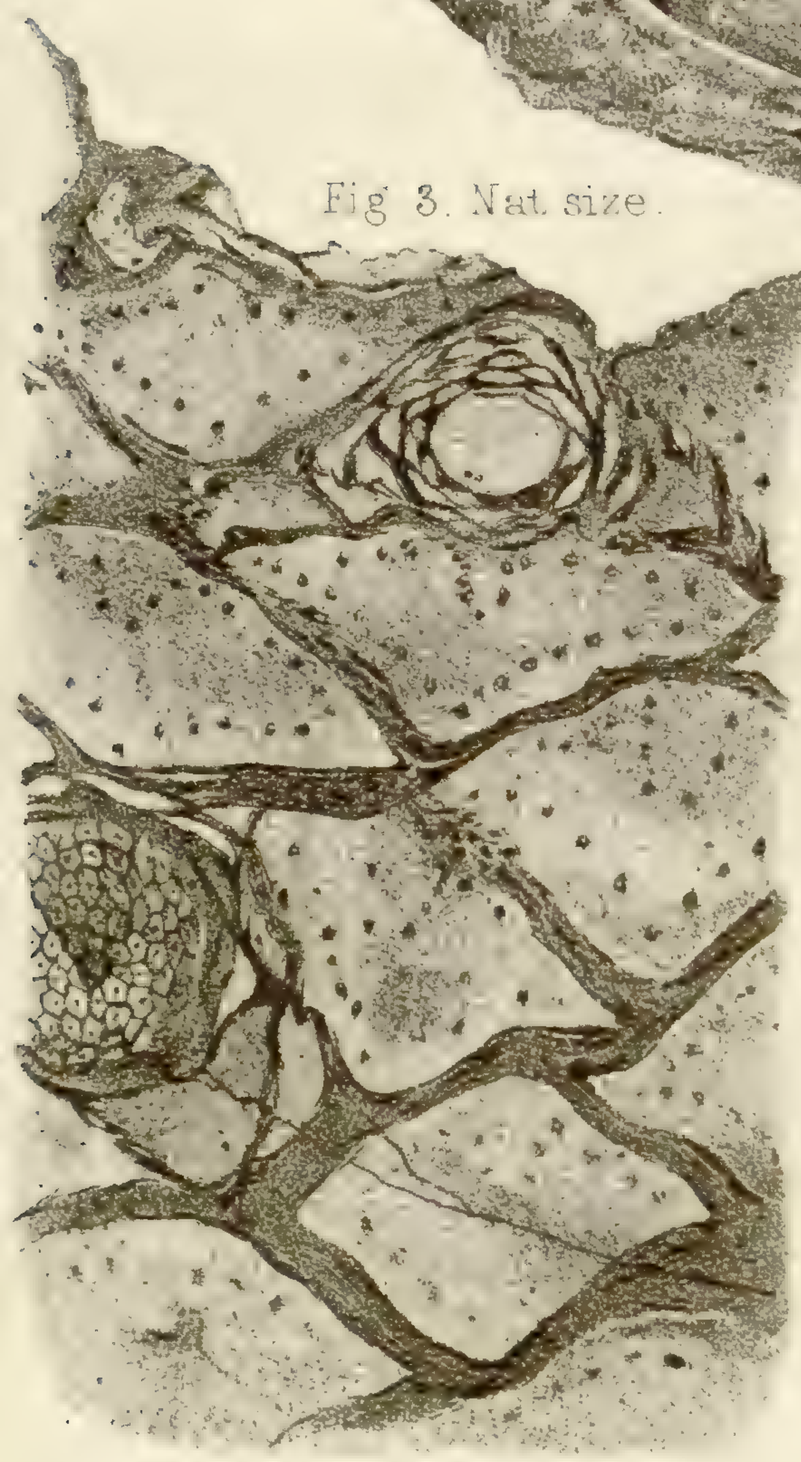

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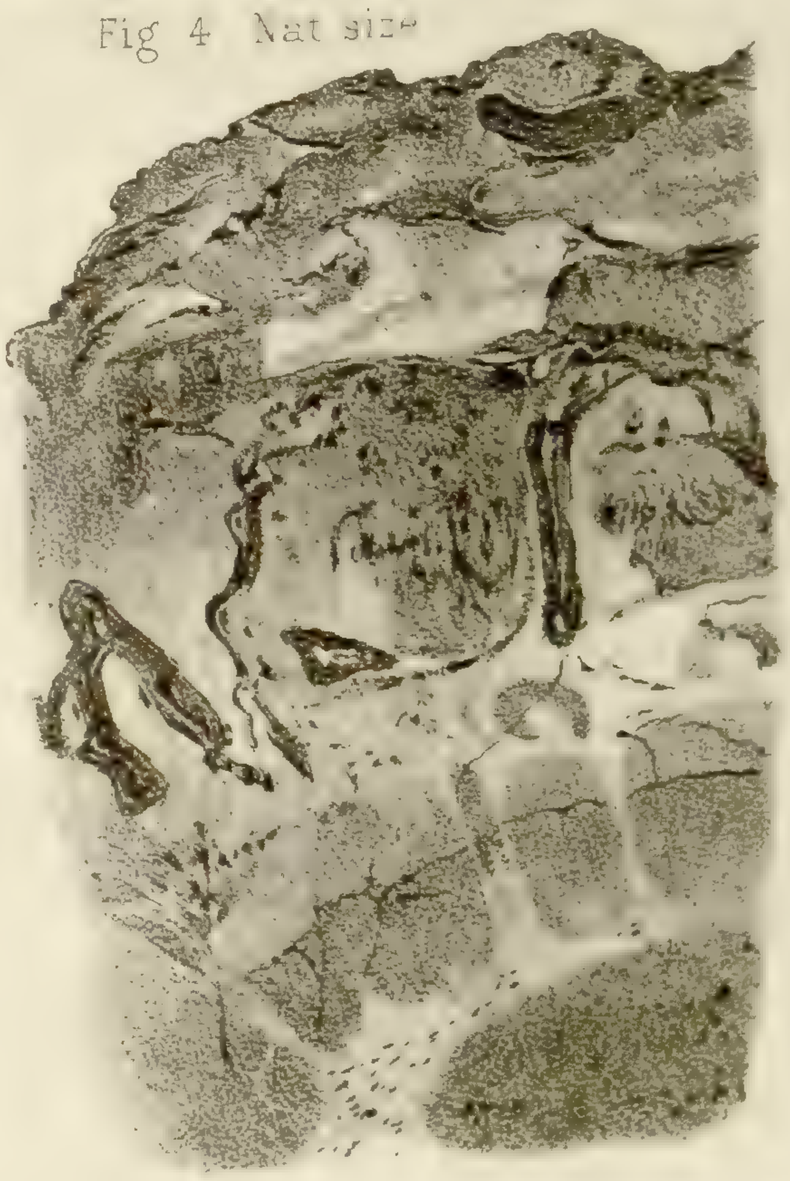

F. E. Smith ad nat. lith

Bennettites Gibsonianus

Fig. 1. Twice nat. size.

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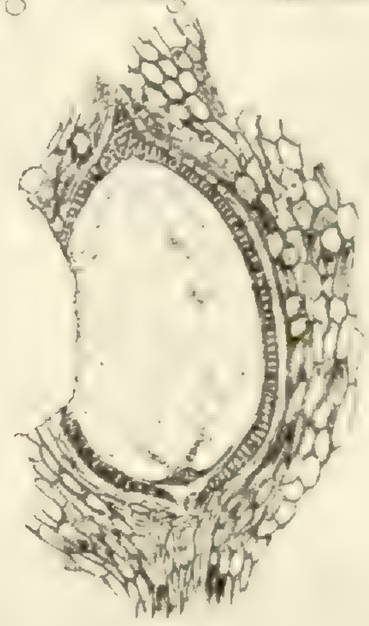
Fig. 7. Mag. 8 times.



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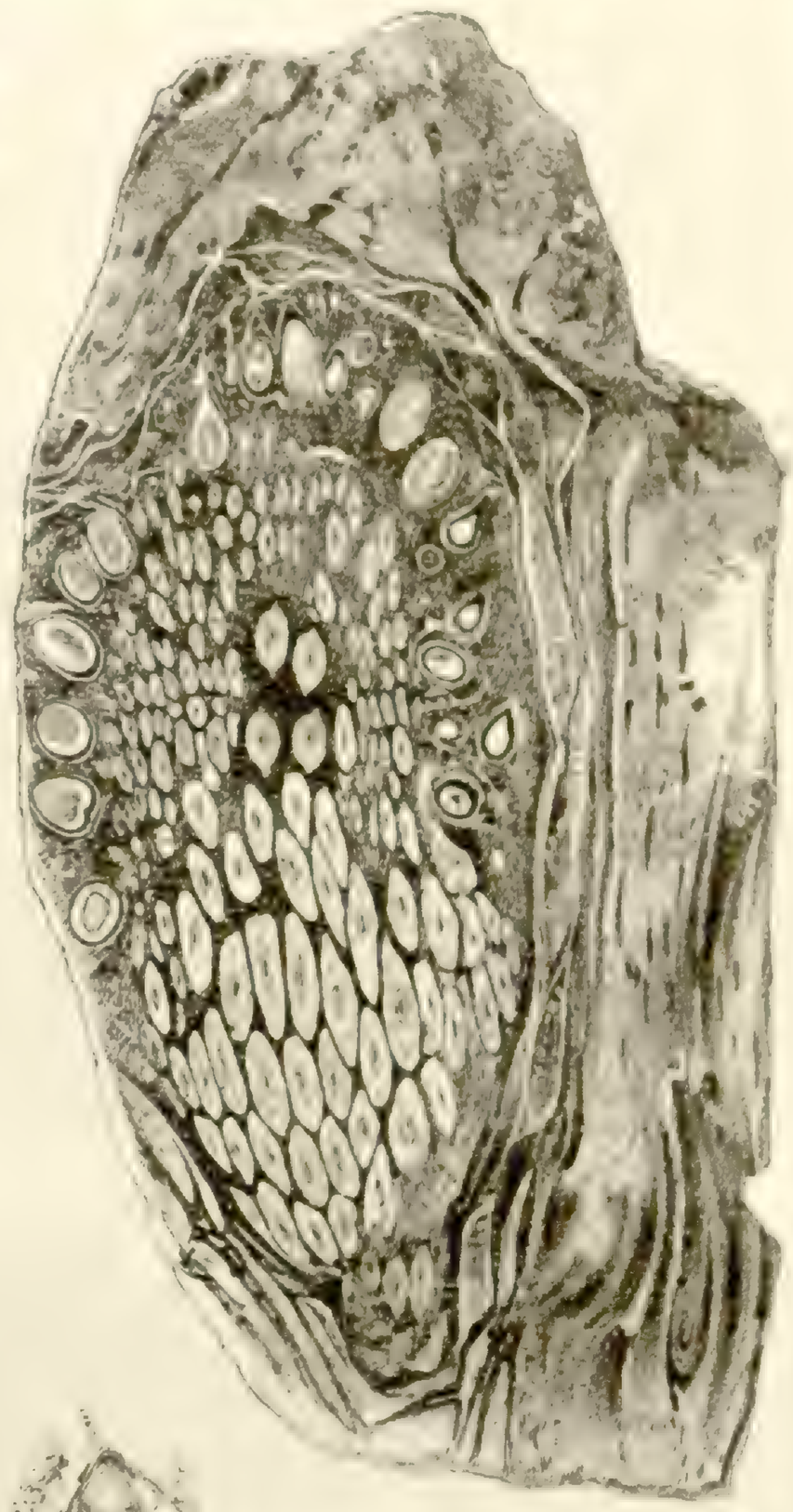

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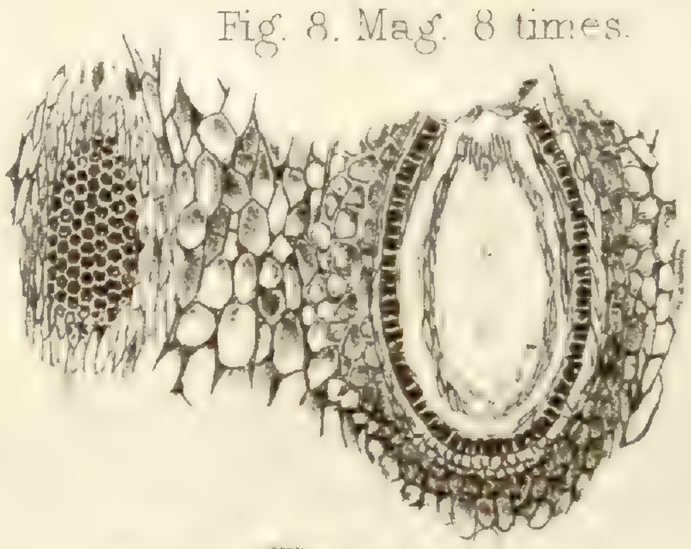

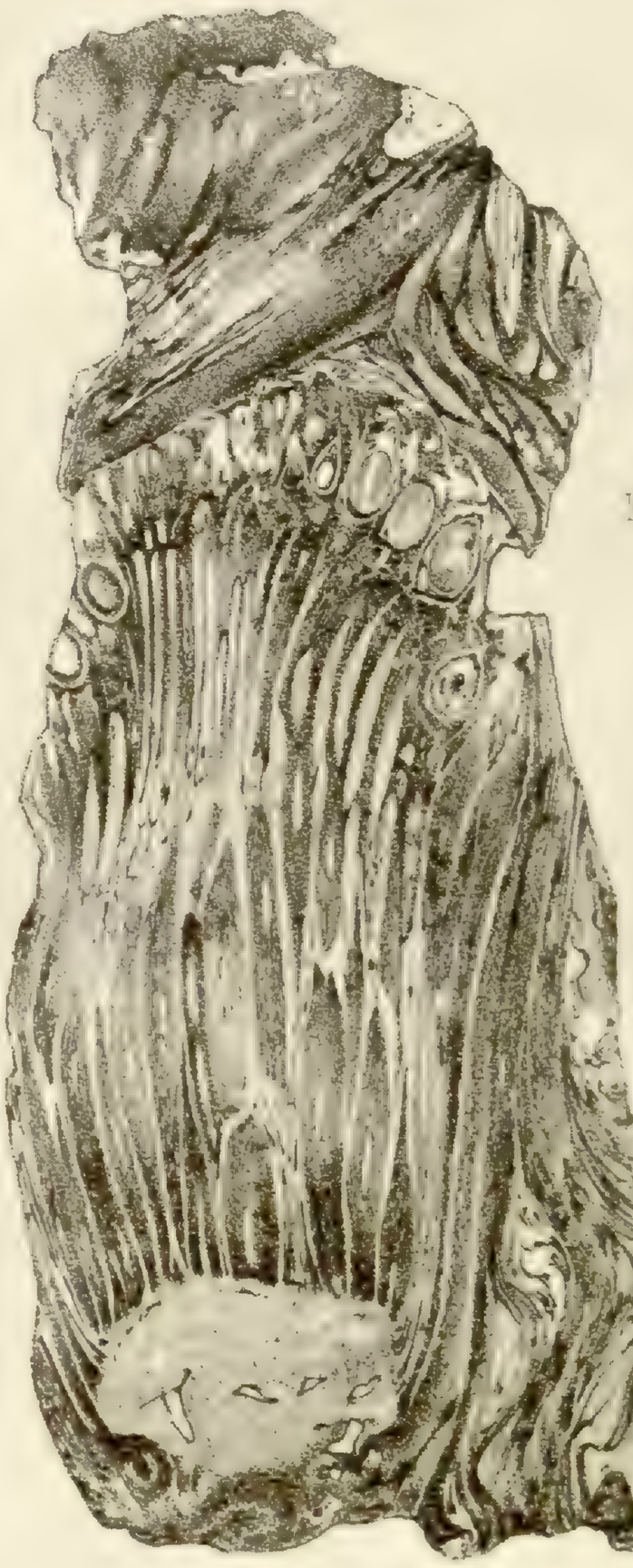

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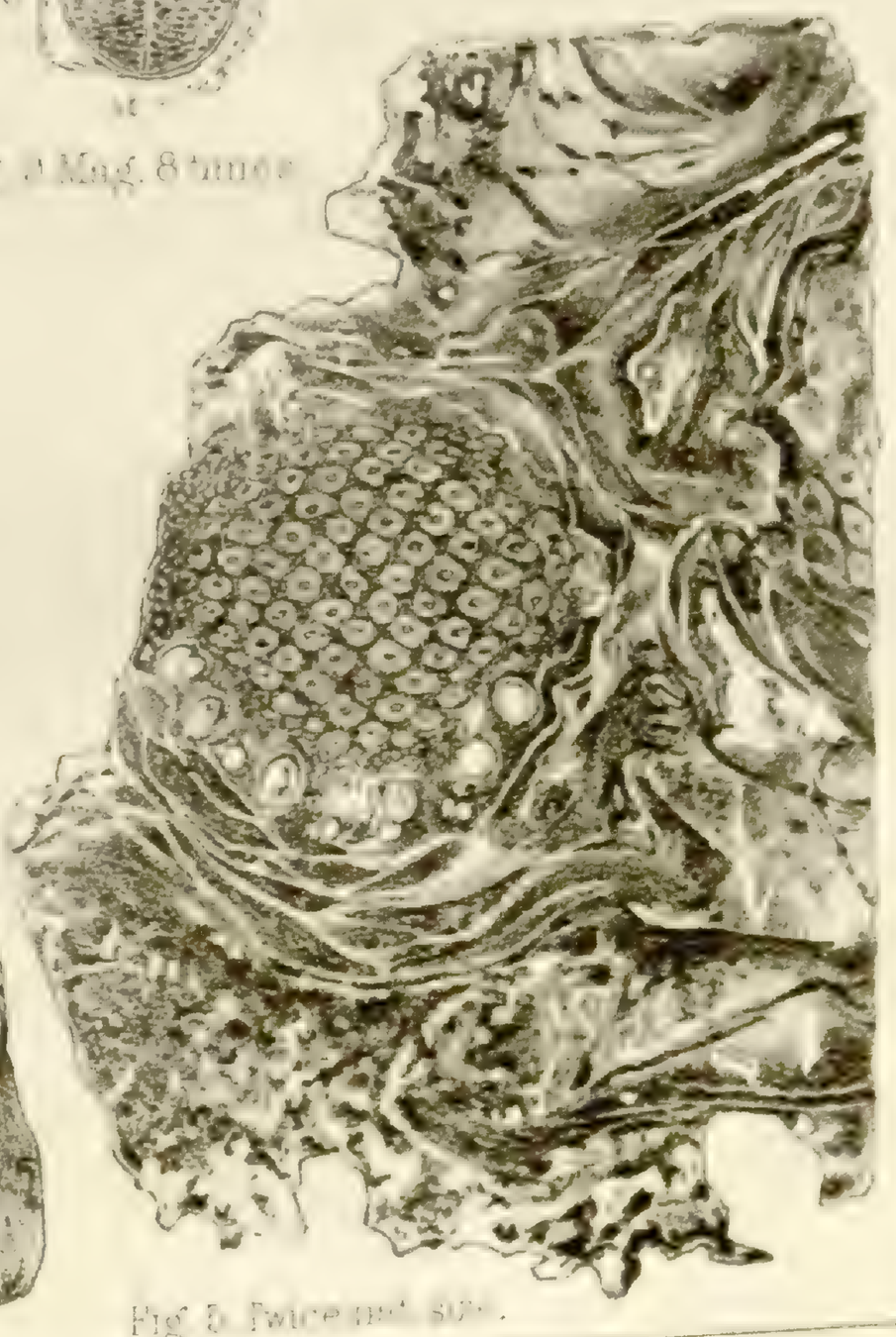

Fig. 4. Twice nat. size.

Fig. 3. Twice nat. size.

Fig. 5. Twice nat. size.

W. G. Smith, ad nat. lith.

Bennettites Gibsonianus.

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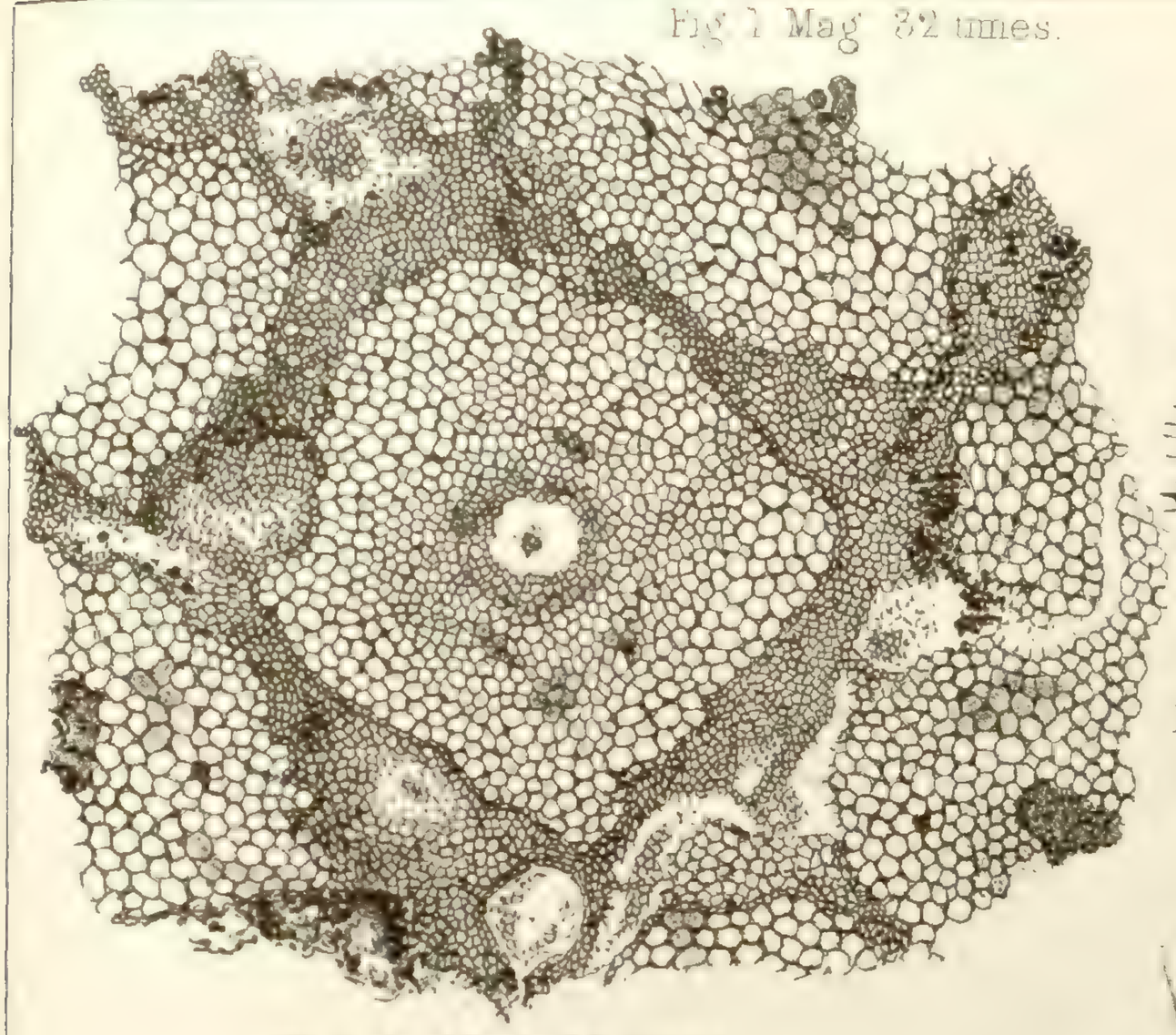
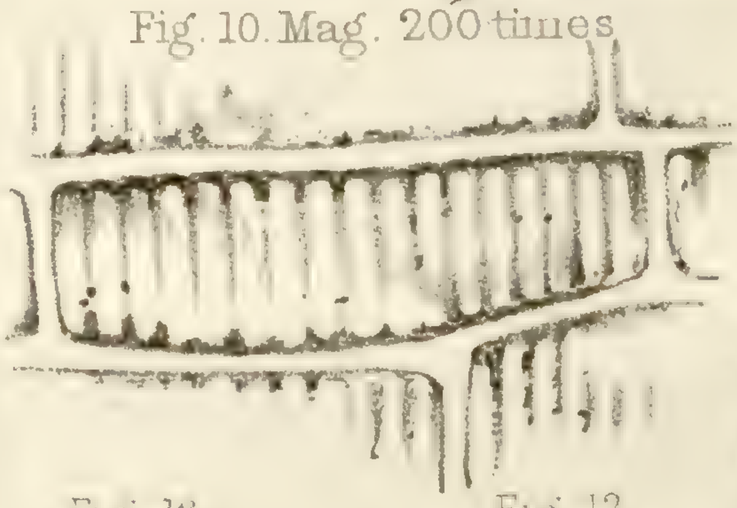


Fig. 3 Mag. 32 times

Fig. 10. Mag. 200 times



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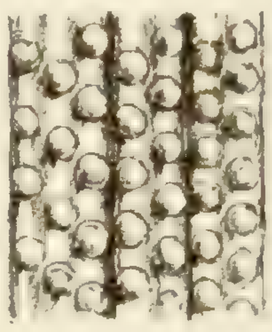

Fig. 12

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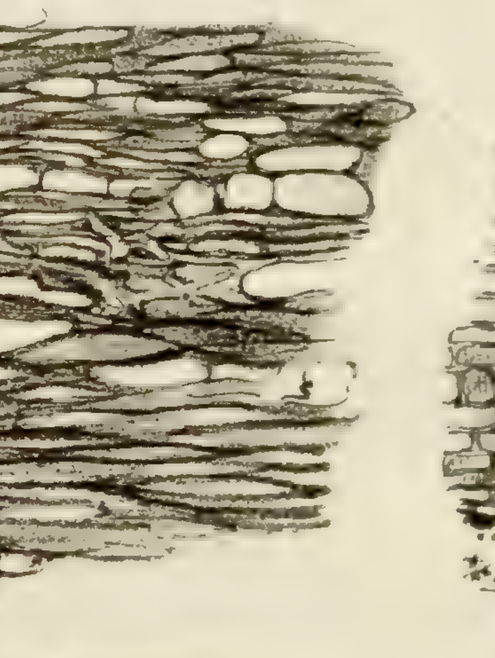

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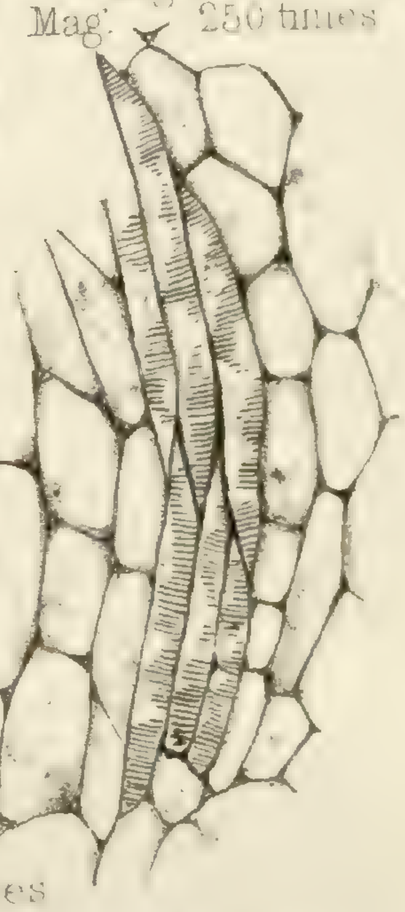

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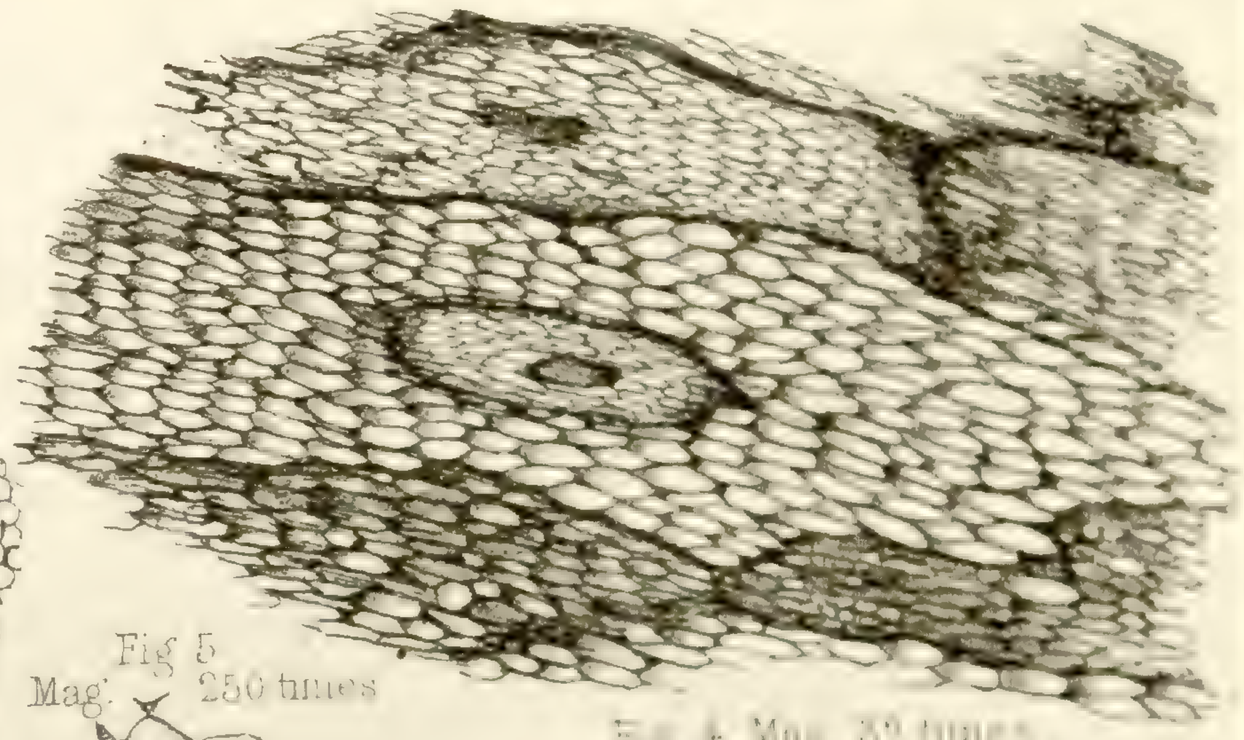

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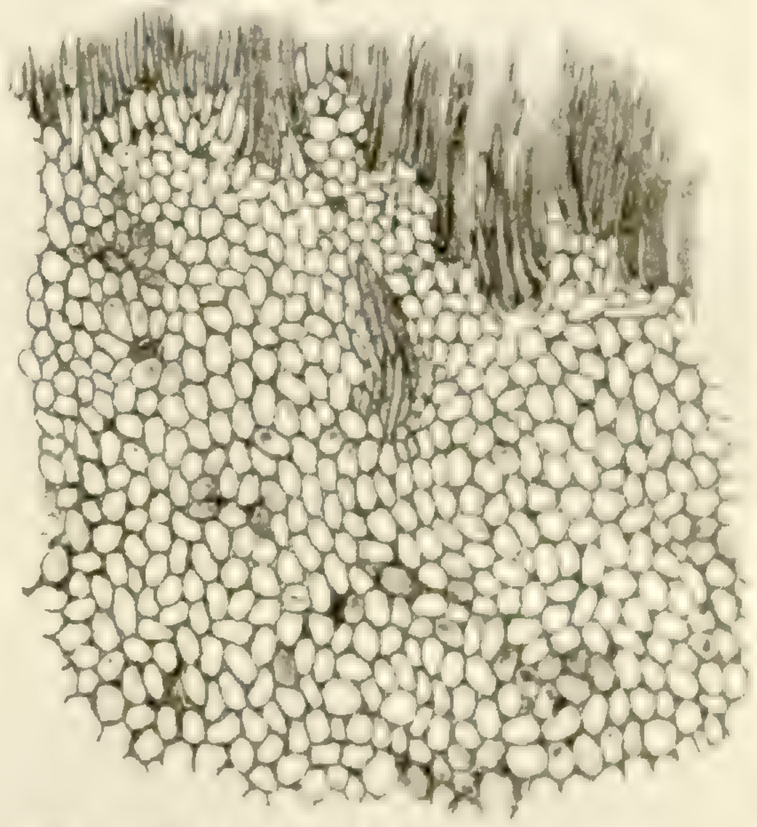

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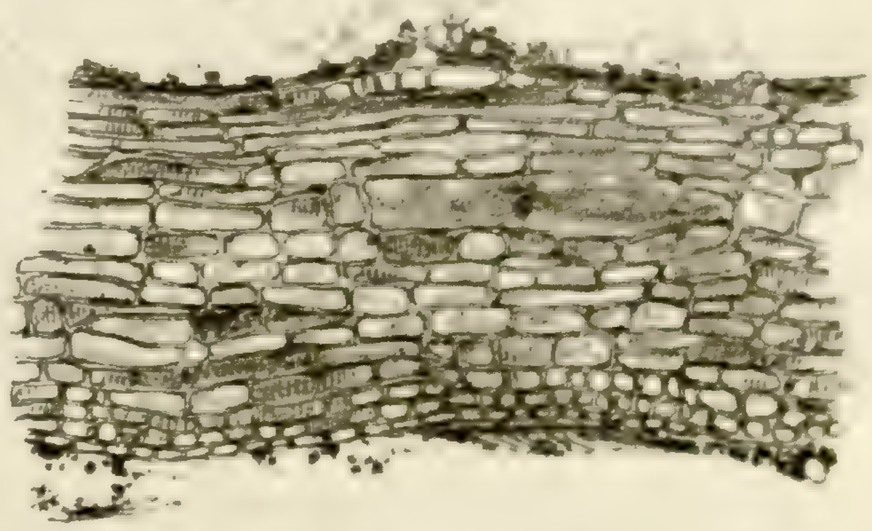

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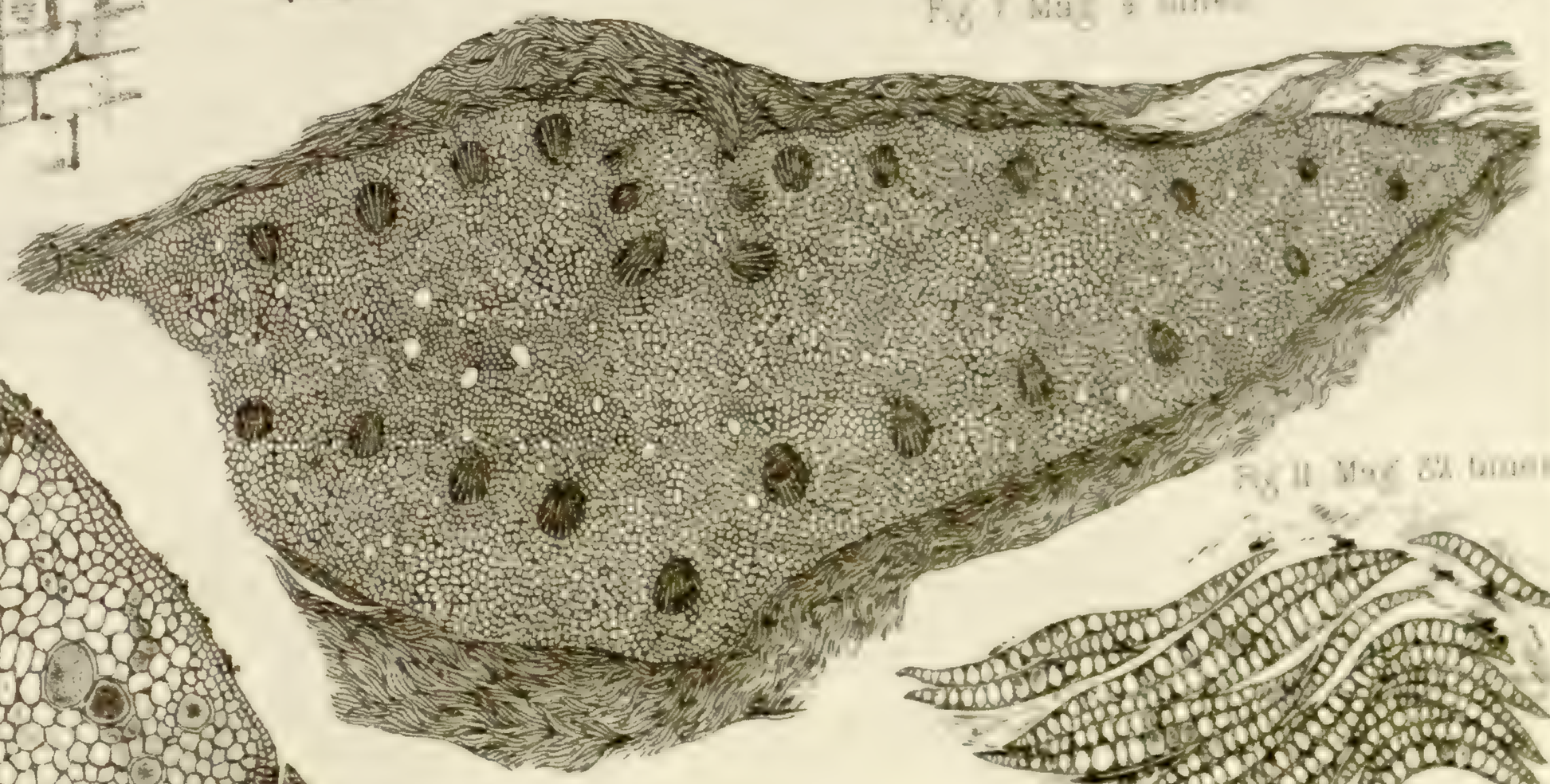
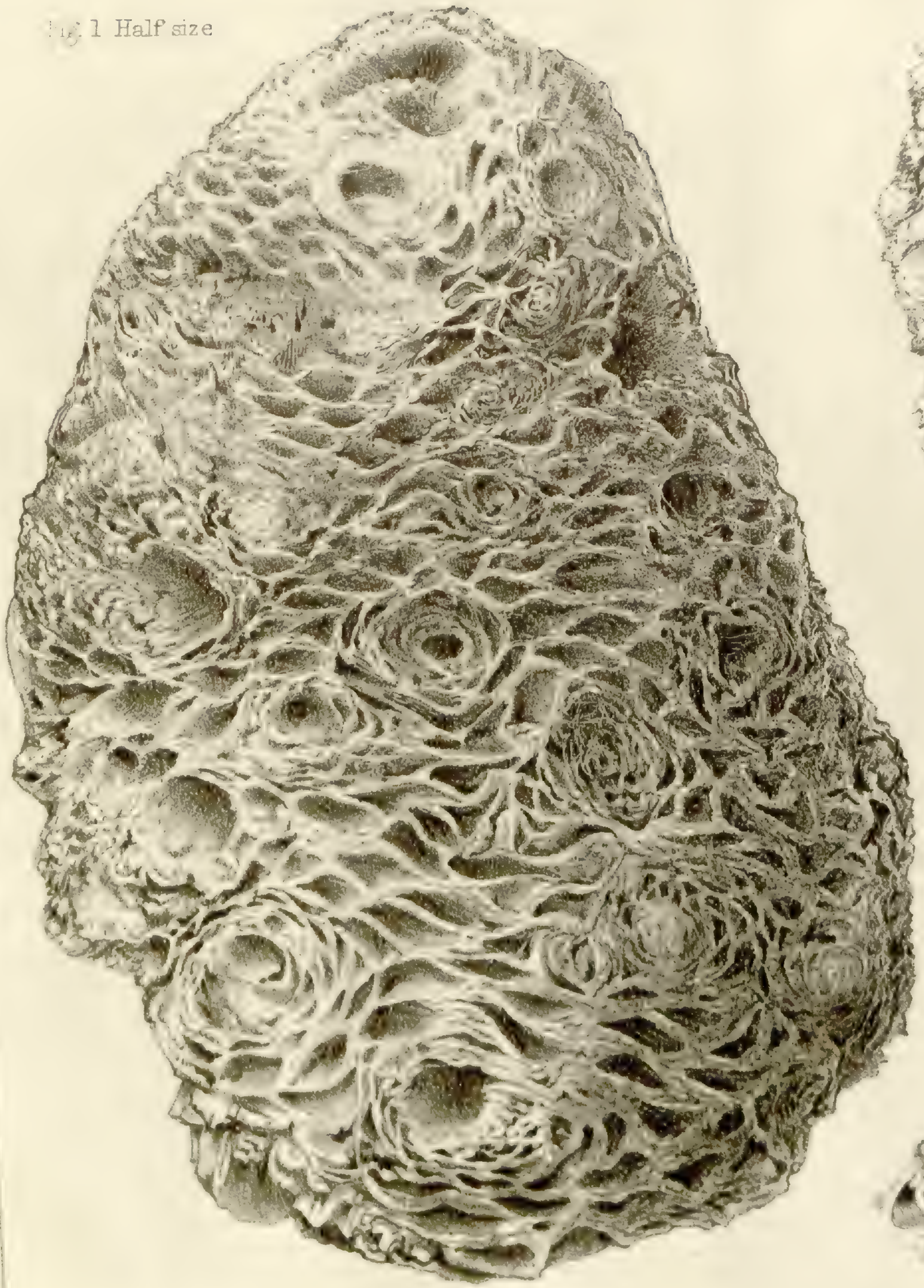


Fig. 11 Mag. 32 times

Fig. 6 Mag. 32 times.

W. G. Smith. ad nat. lith.

Figs. 1–12 Sporadinia Grevillei. Fig. 13 Yatesia Morrisii



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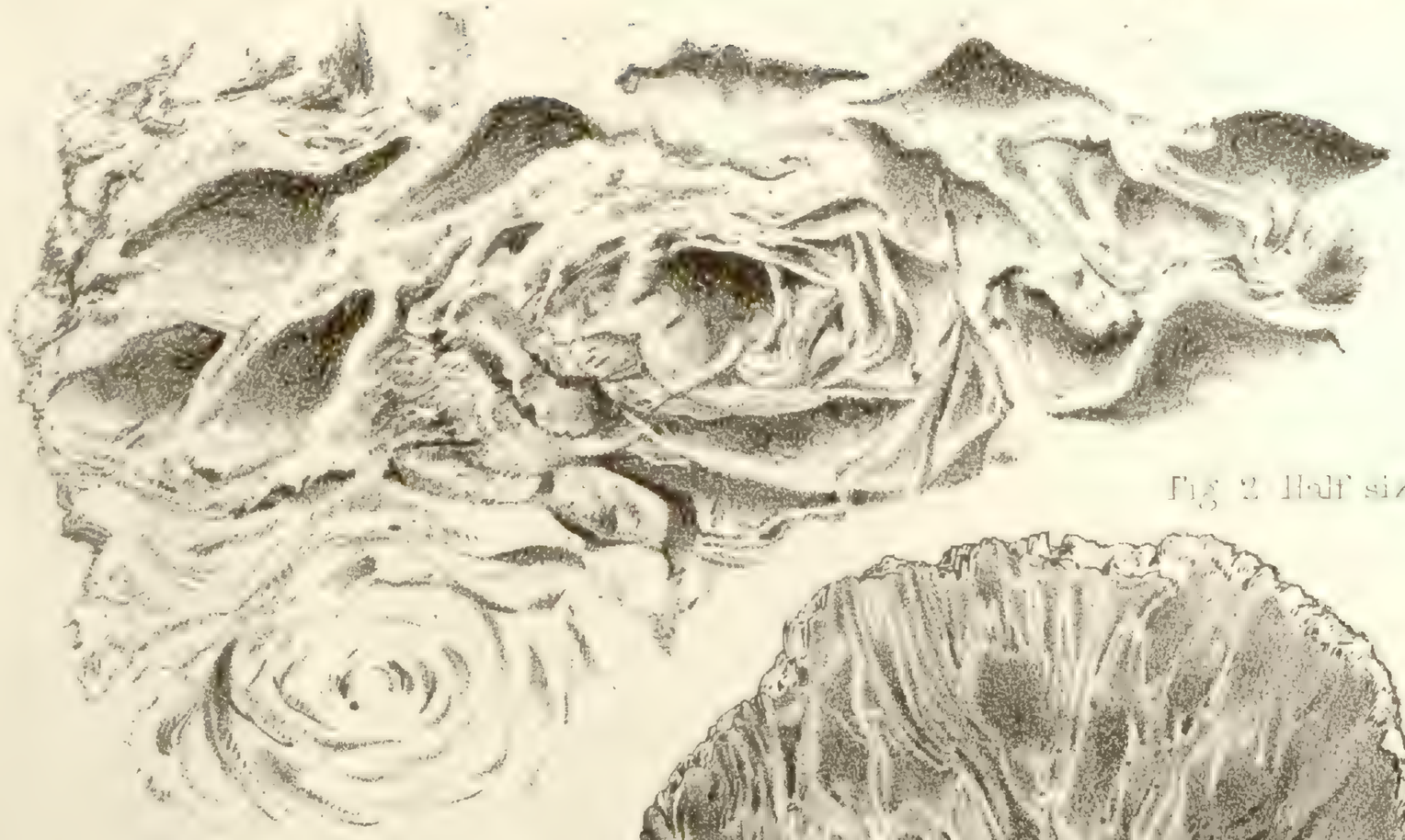

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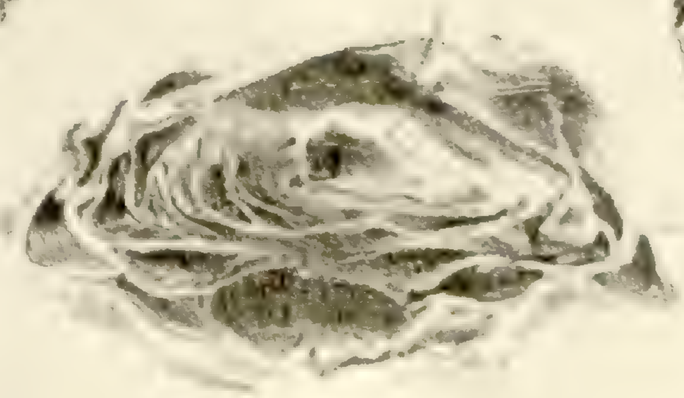

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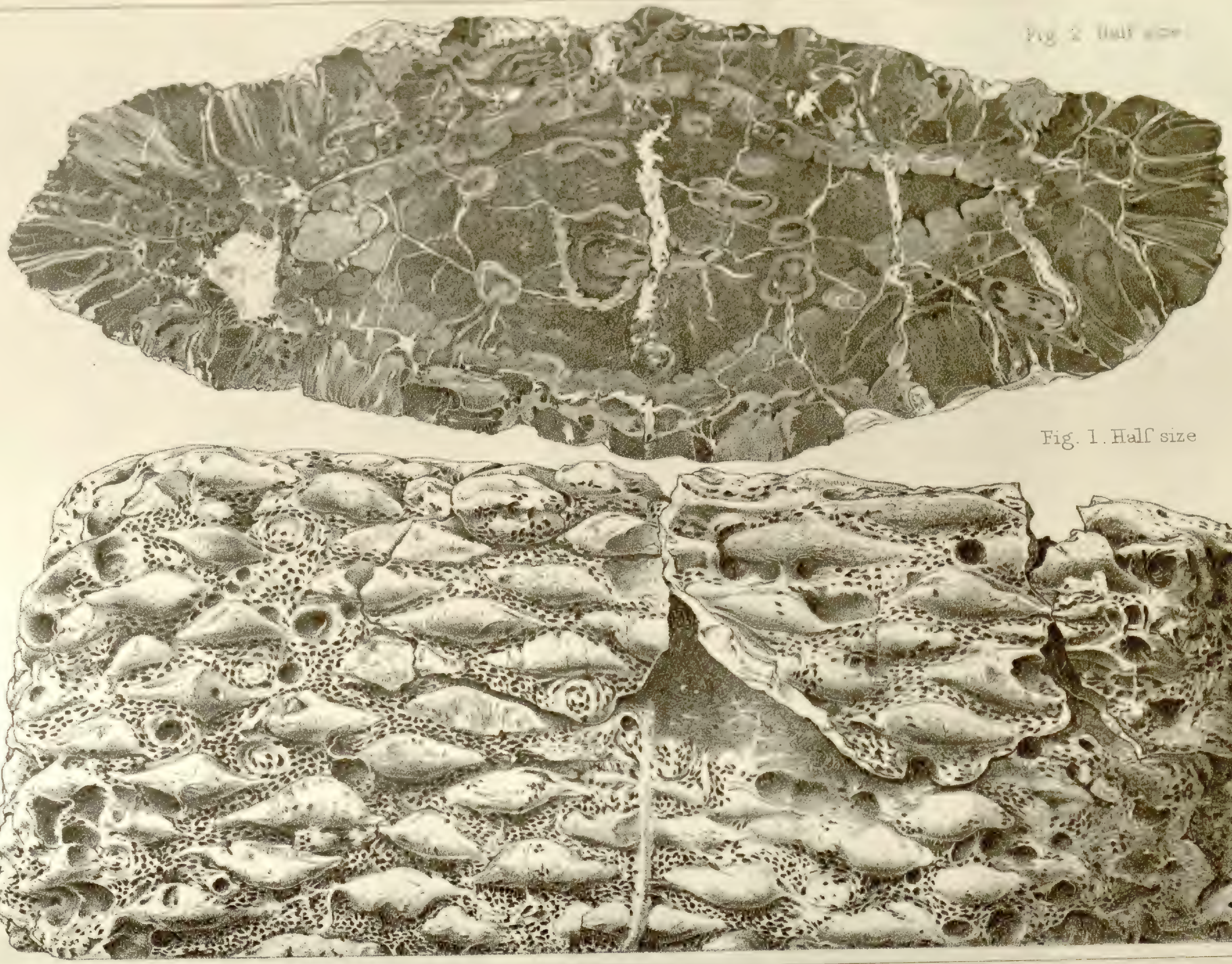
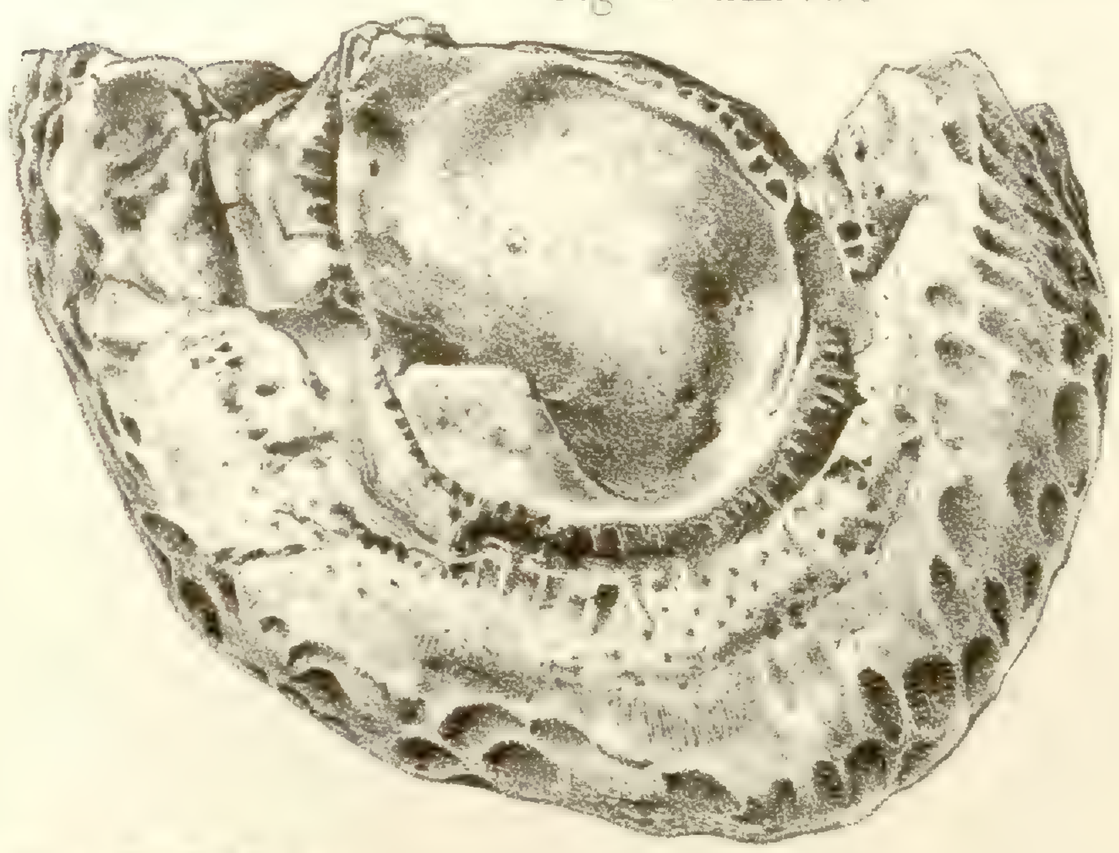


Fig. 1. Half size

Bennettites Peachianus.

W. G. Smith, ad nat. lith.

Fig 2 Half size



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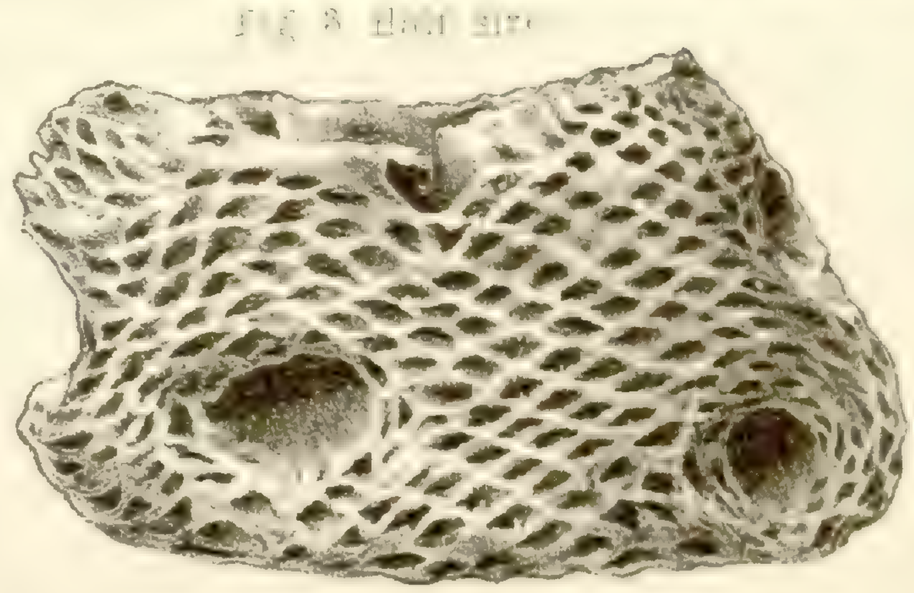

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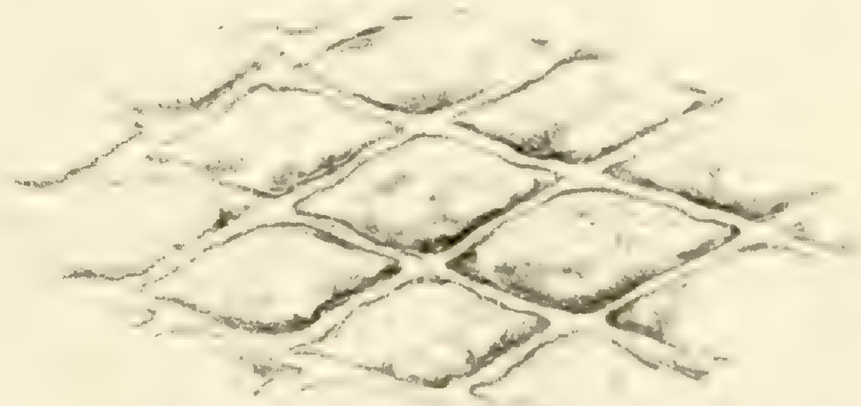

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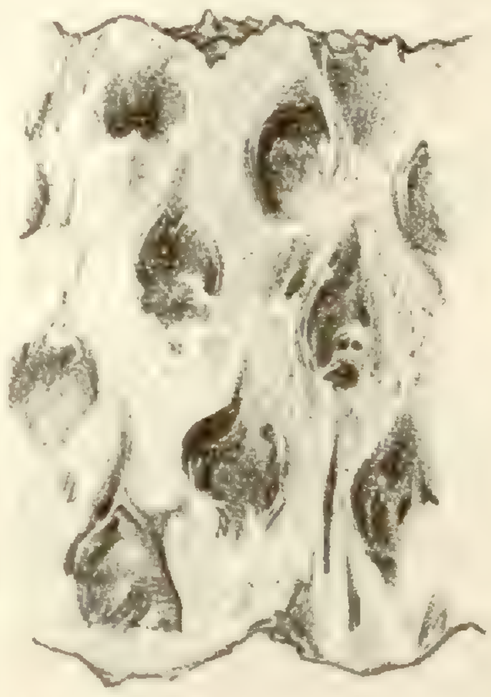

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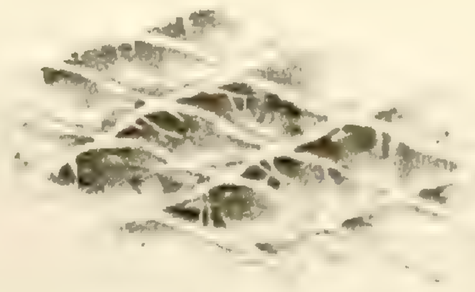
Fig 6 Half size



W. G. Smith. ad nat. lith.

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